THE SCIENCE TEACHER

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THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

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Volume 27, Number 5 • September 1960

Editorial

Since its inception, your Association has examined and explored many facets of science instruction. Its success in many endeavors is evident from the growth of the membership and the influence and effort directed to school science development. This past year has seen much reorganization within the Association preparing it to serve the membership, science education in general, and the nation's youth. Special emphasis has been placed upon development of a better K-12 science curriculum. Although much has been accomplished in curriculum development, considerable work needs to be done before the problem can reach a reasonable solution. Actually, as we all know, the problem of the curriculum is one that will ever be present.

The important and guiding forces at the base of our educational system are the classroom teachers, superintendents, principals, supervisors, and counselors. If they function properly and contribute to the efficiency and success of the classroom, much can be done to advance our science education program. If classroom instruction is poor, misdirected, or inadequate, of what value is the superstructure?

It is in the classroom that the boy or girl is introduced to the learning situation. It is personified by the teacher. That experience may be happy, profitable, and inspiring—or it may be disagreeable, monotonous, and deadly. Which it shall be is to no small extent determined by the teacher.

Furthermore, what is the sense of developing sound, effective curricula full of fascinating materials, problems, and information, if, in the classroom, you have an instructor incapable of utilizing properly these materials or interpreting their applications?

Thus, we are proposing that in the year ahead our attention be centered on the advancement of *the science teacher* and the pursuit of excellence in an *Age of Science*. We are not unmindful that there are other areas of experience that are extremely important, such as language, music, social studies, and other fields, but these are best left to those whose enterprise it is to develop and promote them.

To assist the teacher whose weakness may lie in the knowledge of specific subject areas, we have many programs promoted by organizations such as the National Science Foundation usually working through the universities, programs developed by the universities working independently, and programs by many groups in industry. Several of these plans have been functioning for a number of years and are contributing considerable data and materials in the varied subject areas.

But what are some of the other factors involved in teacher success? For the purpose of this brief introduction we may divide them into four groups. First, there are those involving the personal qualities of the teacher—patience, tolerance, an interest for the age group with which he works, friendliness, and a sincere desire for growth. These and others are frequently mentioned as attributes of the teachers considered as outstanding leaders.

Secondly, the teacher and his relationships with other members of the staff are extremely important. He must make proper use of any help afforded him. Where student teachers are available, a situation is created involving careful evaluation. How much help, such as laboratory and clerical assistants, should be provided? And the eternal problem of committee and extracurricular activity must be taken into consideration.

Thirdly, we have the question of the laboratories, equipment, teaching aids, and a thorough acquaintance of what is available for present-day teaching.

And fourth, perhaps the most important in contributing to success as related to the above factors is that of the economic well-being of the teacher. Will we be able to retain and recruit able teachers willing to keep abreast of the scientific progress in the face of substandard salaries?

To what extent may your Association assist the school administration and the teachers to arrive at sound, concrete proposals to serve as guides?

Obviously here, as in all matters human, the laws of variability limit action as to the results since no precise rule-of-thumb programs can be developed. However, there are a number of guides sufficiently universal toward which attention could and should be directed to those involved, and which in the end would give us: Science Teachers, Seeking Excellence in an Age of Science.

ROBERT A. RICE
President, NSTA (1960-61)

STAR Hibernates

Programs of STAR awards for teachers have been conducted by NSTA in 1956, 1958, and 1960 under grants from the National Cancer Institute. The Association hopes to continue this awards program, probably on an alternate-year basis. Thus there will *not* be a STAR program for 1960-61. This announcement is made to forestall the large number of inquiries received at NSTA headquarters in the "off years." Thanks for all the interest shown in the program, however; and if we may venture a suggestion, why not use this year to consider and develop an outstanding science teaching idea, then report it in a forthcoming STAR program.

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MEMBERSHIP

The membership year extends for one year from date of enrollment. Subscriptions are entered for either the calendar year or the school year.

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* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.

Letters

TO NSTA REVIEWERS

NSTA, on behalf of its officers and staff, takes this opportunity to acknowledge with gratitude and sincere appreciation the work of Dr. Robert A. Bullington (Chairman), and the excellent cooperative efforts of his committee in contributing reviews for the Science Teaching Materials section of *The Science Teacher*. The committee members associated with Dr. Bullington since September 1958 included the following: Miss Rosemary Anderson, Dr. Jack Bennett, Dr. John Bower, Dr. Loren T. Caldwell, Mr. Kenneth Clayton, Mr. Donn D. Darsow, Mr. Mason G. Fenwick, Dr. Harvey A. Feyerherm, Dr. Howard W. Gould, Mr. James H. Grosklags, Dr. B. Ross Guest, Mr. Kenneth H. Harmet, Dr. Mazhar Hasan, Mr. Walter E. Hauswald, Miss Lillian Hirsch, Mr. Thomas M. Janeway, Mr. Voris V. King, Dr. Wendell A. Lindbeck, Mr. Howard F. Matz, Mr. Wallace B. Miner, Mr. Carol K. Mathers, Dr. Ruben L. Parson, Dr. Martin Reinemann, Dr. Charles J. Rohde, Jr., Miss Bernice Roth, Miss Virginia M. Schelar, Mr. Eldon G. Scriven, Dr. Edwin Shykind, Mr. Robert L. Smith, Mr. William E. Southern, Mr. George P. Stevens, Dr. George L. Terwilliger, Mr. Herbert Tischler, Mr. Peter Y. Tsao, Dr. Bruce Von Zellen, Dr. Allen D. Weaver, Mrs. Alda Weedman, Mr. Robert Weirick, Dr. Harold A. Winters, and Mr. Robert C. Wittrup.

The article, "Migration of Ions," by William N. Nichols, published as a STAR '60 feature in the May 1960 issue, contained an error of interpretation which is unwarranted and unlikely on the basis of information.

The writer claims (last paragraph, page 22) that "the sodium ions migrate through the glass, through the gaseous medium inside the bulb, and to the hot filament. The positive ions are there reduced to sodium atoms which plate out on the upper, cooler part of the bulb." It is exceedingly unlikely that the sodium ions can move to the hot filament; it is much more likely that the electrons will move from the filament to the inside wall of the bulb. This has been shown to be true in several ways, notably through a crucial experiment in which an outside magnetic field causes the stream of electrons to move, altering the deposition of metallic sodium.

A review of this subject is contained in the paper by D. K. Alpern, *Journal of Chemical Education*, 34:289. June 1957.

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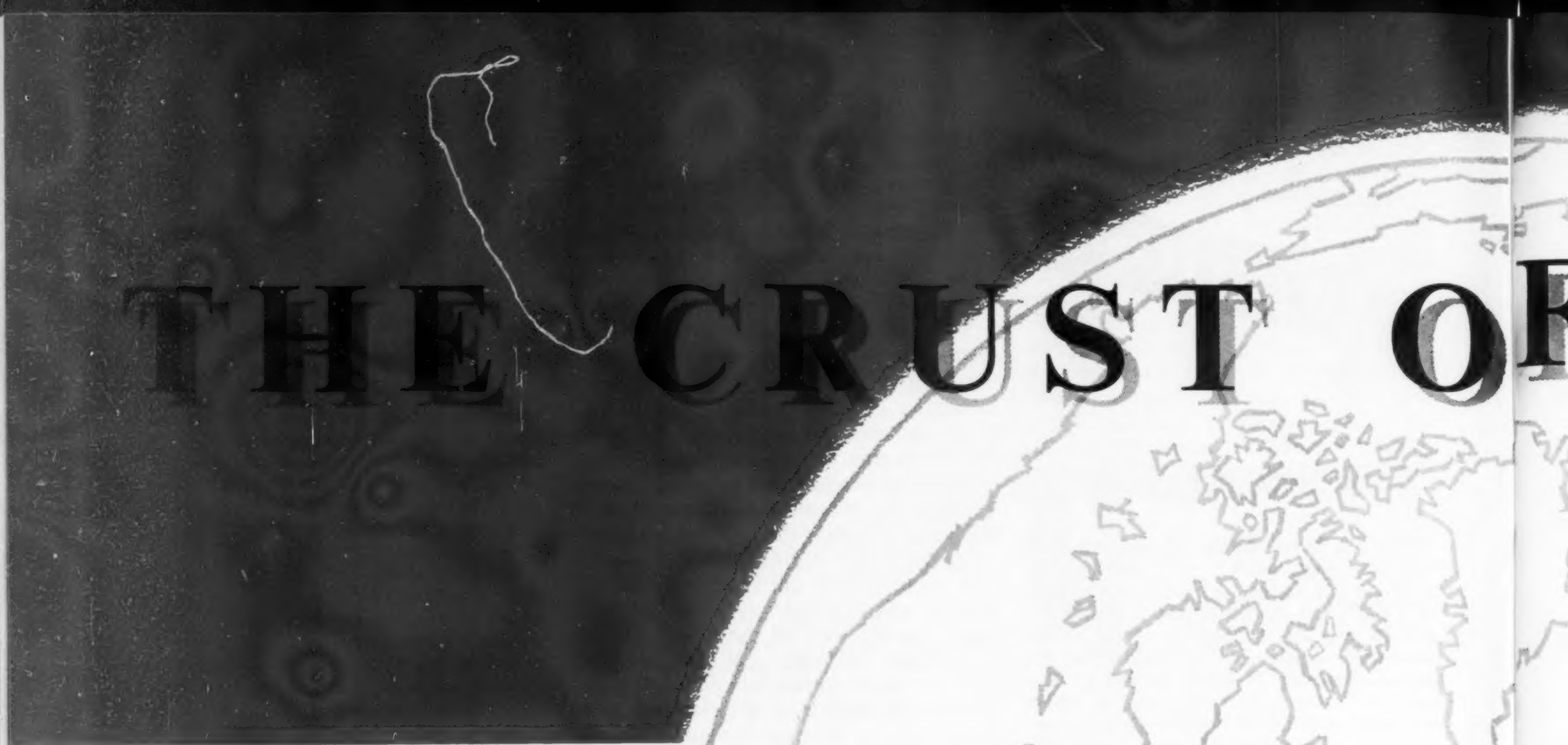
THIS MONTH'S COVER . . .

The noted photographer, Ansel Adams, captures the earth in all its splendor in the many scenic wonders of the book *This Is the American Earth,* featured in the Book Review section on page 55. Mr. Adams' cover scene, "Pasture," is an original photograph, Sonoma County, California (courtesy of the Wells Fargo Bank and American Trust Company).

Nancy Newhall, author of the inspiring prose poem in the book, expresses eloquently the conservation theme portrayed in each of the magnificent scenes in this work. No other words can compete with her image of the cover scene:

> Shall we not learn from life its laws, dynamics, balances?
> Learn to base our needs not on death, destruction, waste, but on renewal?
> In wisdom and in gentleness learn to walk again with Eden's angels?
> Learn at last to shape a civilization in harmony with the earth?

THE CRUST OF



Introduction

That the earth has an internal structure not unlike that of a liquid-center golf ball is known from the travel times and types of seismic waves that are transmitted through it from earthquake shocks. As indicated in Figure 1, in gross form this structure can be described as a thin outer crust 5 to 65 kms thick, an underlying mantle about 2900 km thick, and a central liquid core at whose center at a depth of about 5100 km there appears to be an inner solid core. The crust, which is the subject of this paper, is of particular interest as it constitutes the surface upon which man lives. The stability, mineral composition, surface relief, and evolutionary changes of the crust all have a direct bearing upon man's activities, wealth, and even life itself, as brought out by the disastrous earthquakes in Chile last spring.

General Description of Crust

Basically, the crust can be thought of as floating upon the underlying mantle layer as though it were supported by a liquid. Actually, the mantle rock material is solid, but like most materials subject to long-term stress it appears to yield by plastic flow to the variations in pressure imposed by changes in weight of the overlying crust. This phenomenon of plastic flow of solid material can be observed in a short-period experiment by placing a heavy hammer upon the surface of a barrel of solid tar. Given sufficient time the hammer will not only sink into the tar but eventually will sink to the bottom of the barrel. The same tar, struck a blow with the hammer, would show no visible imprint although the surface might be locally shattered as if it were glass. Therefore, the factor of time is an important one in considering all tectonic processes involving the crust, and the complex folding of normally brittle rocks that is observed in many mountain ranges is evidence that the earth's crust itself has undergone considerable plastic deformation over the years.

The concept that the crust is in effect floating upon the underlying plastic mantle material, i.e., displaces its own weight in the mantle layer, is not a new one, but there was little or no proof to support this concept until recently. As long ago as 1855, Sir George Airy advanced the idea of a floating crust to explain why the gravitational attraction of mountainous masses on a plumb bob is invariably less than that which was computed. This conclusion is also substantiated by gravity measurements. For example, it is observed that if one allows for the gravitational effect of changes in latitude (change in earth radius and the outward centrifugal force), change in elevation, and the gravity effect of the included mass of material above the mean surface of the earth (geoid) represented by sea level, the theoretically computed values depart from the actual variations in gravity in a systematic manner that is dependent upon elevation. This departure is referred to as the Bouguer gravity anomaly in recognition of the French scientist by that name. He did pioneer gravity work (1740) in the Andes Mountains at the time of the famed expeditions of the French Academy to Lapland and what was then Peru (now Ecuador) to determine whether the earth was really flattened at the poles rather than at the equator, as some scientists thought at that time.

The Bouguer anomaly values show an inverse relationship to elevation and suggest a compensating negative mass at depth whose gravity effect offsets that of the surface mass distribution. This phenomenon, known as isostasy, implies that at some depth below the surface all terrestrial columns exert equal pressure. This situation, as visualized by Sir George Airy, was analogous to the pressure exerted on the bottom of a harbor filled with shipping. As any floating body, in accordance with Archimedes' principle, displaces its own weight of the supporting medium, the bottom pressure everywhere will be the same whether a ship is overhead or not, or whether the vessel is a light rowboat or a deeply laden cargo vessel. Under this concept of isostasy the crust should be thicker beneath the continents than

OF THE EARTH

By G. P. WOOLLARD

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beneath the oceans, and beneath mountains there should be downward projecting "roots" analogous to those associated with icebergs floating in the sea. The amount of root beneath a mountain would thus be directly proportional to the height of the mountain.

An alternate interpretation for isostasy, however, had been advanced by the Archdeacon Pratt in 1854. It visualized the mountains as standing high because they are composed of lower density material. This is sometimes referred to as the "dough" theory of isostasy in that it implies the crust of the earth has risen to varying elevations in response to some internal mechanism affecting its density, analogous to having varying amounts of yeast in different batches of bread dough on a table top. For years geologists debated not only the merits of these two different theories concerning the crust, but also the reality of the phenomenon of isostasy itself. It was not until the techniques of exploration seismology, as used for mapping subsurface geologic structure in the hunt for favorable locations for the entrapment of oil, were adopted to the study of the crust that the problem was resolved.

Seismological Study of the Crust

The seismological study of the crust dates from 1910 when a Yugoslav seismologist, Mohorovicic, announced that studies of the travel times for a local earthquake in southeastern Europe showed that there was a change in seismic velocity from about 5.7 to 8.0 km/sec at a depth of about 50 kms.

This velocity discontinuity, now known as the Mohorovicic discontinuity, or more familiarly as the "Moho," is one of the earth's most consistent seismic horizons. As its depth appears to vary directly with the surface elevation, and also appears to confirm the conclusion reached from the study of gravity data and the deflections of the plumb bob that the crust appears to be floating and in a state of hydrostatic equilibrium, the "Moho" has been adopted as a seismic marker for defining the base of the crust.

Although the "Moho" was discovered through the analysis of earthquake wave travel-time data, this method of study is neither as efficient nor as reliable as that based upon explosive seismological techniques which permit one to carry out controlled experimental studies of the crust. The following description, therefore, of current seismic methods of crustal study is confined to explosion seismology.

The seismological study of the crust using explosions depends upon the physical laws of optics and particularly the refraction and reflection of compressional sound waves generated by an explosion. By controlling the time of an explosion and knowing accurately the distances from the point of the explosion to a series of seismic wave detectors and the time of arrival of the wave front at each, it is possible to determine both the internal structure and thickness of the crust. The seismic-reflection method of depth determination is identical to that embodied in the use of the Fathometer for the determination of the depth of water at sea. A sound pulse is generated by an explosion, and the time it takes a reflected pulse (echo) to return is a direct gauge of the distance to the reflecting horizon. The reliability of the method is dependent upon a knowledge of the velocity with which sound is transmitted through the intervening medium. If the crust of the earth were a layer of homogeneous material, the reflection technique would adapt itself very well to the measurement of variations in crustal thickness. The earth's crust, however, is far from homogeneous. In most areas it is composed of from two to four layers, but the number of layers and their velocity characteristics change from place to place. To adequately map any such

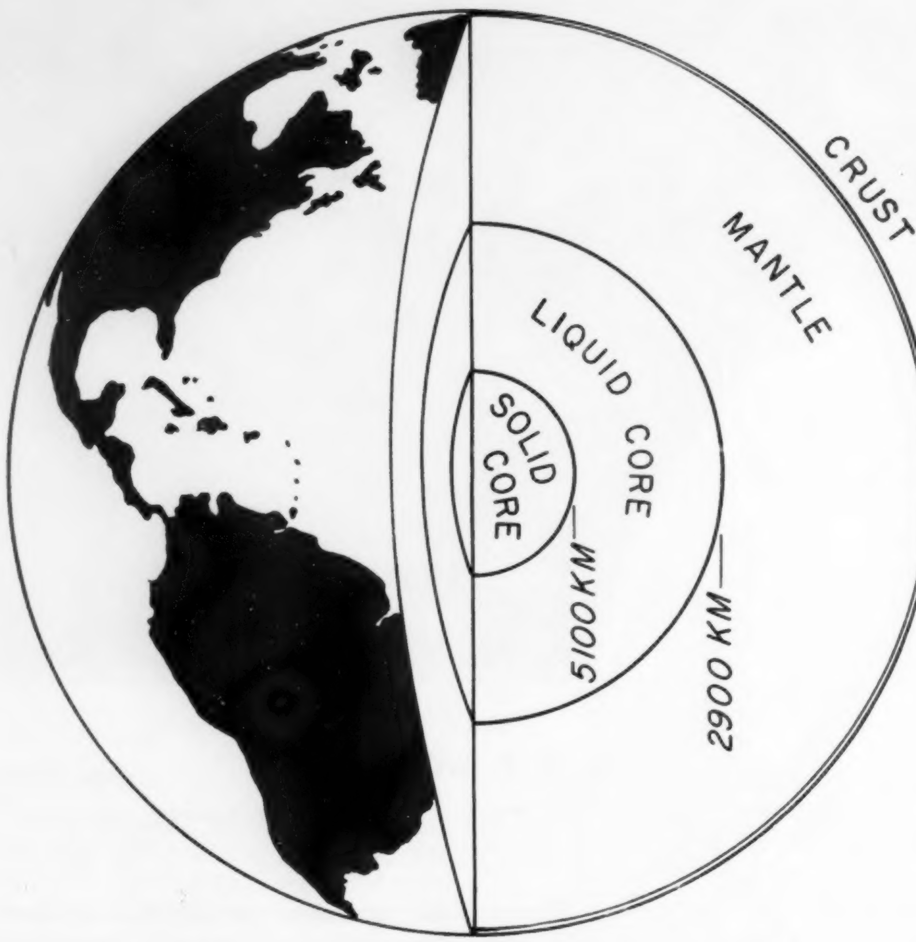

FIGURE 1. Cutaway section of earth showing basic internal structure.

structure, it is best to use a technique which will permit the velocity of each layer and its thickness to be determined. This can be done by using what is known as the seismic refraction method. In this method the arrival times of the explosive sound pulse are recorded at varying distances out to some distance approximately four times the depth that is to be investigated. Instead of timing a vertically or near vertically reflected echo, the times recorded are those for sound that has traveled a predominantly horizontal path between the shot point and the detectors. These travel times, when plotted as a function of the distance from the point of explosion (shot point) to the various detectors, thus give a graph composed of segments of straight lines whose slopes are the reciprocal of the velocity at which the sound was transmitted in each layer. If the crust were composed of homogeneous material, the travel-time plot would define a single straight line.

The refraction method is based upon Snell's Law for refracted light. Its successful application depends upon the layering within the crust being essentially horizontal and the fact that the deeper layers have a progressively higher velocity than the material above them. At each velocity layer interface, the energy that is critically refracted (refracted at 90°) into the underlying layer will travel along the boundary interface as a new source of energy radiating sound waves back towards the surface in accordance with Huygen's principle. If the velocity of the underlying layer is less than that of the overlying material, however, the energy incident upon the boundary will be refracted downward in accordance with Snell's Law, and no energy will be returned to the surface by a refracted path until higher speed material is encountered. Fortunately, the geology of the crust is such that it is density-layered with the deeper material not only having a higher density but also a higher seismic velocity. Under these conditions there is upward refraction at each boundary, and the existence of layering is apparent on the travel-time graph by a change in the slope value of the graph. In Figure 2 a schematic representation is shown depicting the relation between the travel-time graph data and the subsurface velocity structure for a three-layer situation. The seismic record (seismogram) shown contains all of the pertinent data concerning time. The shot instant which was relayed by radio to the central recording site is transferred directly to a galvanometer whose deflection defines this event on the seismogram, which is a moving recording strip of photographic paper. Each detector, which consists of a spring-mounted magnetic mass with a high moment of inertia inside of a coil, is likewise connected to a recording galvanometer through an amplifying circuit. Upon the arrival of the seismic wave front at the detector, a differential movement occurs between the coil mounted in the core and the spring-mounted high inertia core that induces a current in the coil. It is this signal which marks the arrival of sound pulse on the seismogram. Time lines are put on the seismogram at .001 second intervals through the use of a driven tuning fork or other device that can be relied upon to break a beam of light at fixed intervals.

Depth determinations are based entirely upon the optical ray theory. The basic depth equation for a two-layer situation, for example, is

$$h = \frac{TV_1}{2 \cos i}$$

where T is the V_2 layer zero-distance time intercept value (see Figure 2), h the thickness of the upper V_1 layer, i the angle of the incident ray refracted at 90° along the $V_1 - V_2$ layer interface, and V_1 the velocity in the surface layer. The values of V_1 and V_2 are taken directly from the graph, as is the value T. The angle of incidence for the ray refracted at 90° at $V_1 - V_2$ interface is determined from Snell's Law, which states

$$\frac{V_1}{V_2} = \frac{\text{Sin incident ray}}{\text{Sin refracted ray}}$$

As the refracted ray is specified for 90° and the sin of 90° = 1, the ratio of the velocity values V_1 and V_2 determined from the travel-time graph define the incident ray. The only unknown, therefore, is h, the thickness of the upper layer having a velocity V_1. Where several layers are involved, equations similar to the one given above are used.

The accuracy of the seismic refraction method where it has been checked by drilling in oil field exploration work is well within ten per cent, and there is every reason to believe that the method gives a similar degree of reliability in the study of the crust.

Results of Crustal Seismic Measurements

Most of the measurements of crustal structure by the explosive seismic method have been done since the end of World War II. The program of measurements has not been restricted to any one continent or ocean and has been literally world-wide in scope. As a result we now have a better idea about the structure of the crust and how it varies in thickness with changes in surface relief. In the oceans, for example, we find that the crust is relatively thin (5 to 6 kms) and that it has a rather simple velocity structure of either one or two layers with velocity values in the range 6.4 to 6.7 km/sec. On the continents, on the other hand, the thickness of the crust at sea level is about 34 kms, and it thickens as the surface elevation increases up to values in the range 55 to 65 kms beneath the high mountains. The internal structure also varies considerably with a single layer indicated in some areas and several layers in other areas. The velocity values vary from about 5.4 to 6.2 km/sec at the surface to as much as 7.6 km/sec near its base. The only factor that appears to be common to both the continents and the oceans is the velocity of the underlying mantle rock which everywhere appears to be characterized by a velocity of about 8.0 km/sec.

Relation Between Gravity Anomalies and Seismic Measurements

As already mentioned, there is a systematic inverse relationship between Bouguer gravity anomalies and the surface elevation that Sir George Airy attributed to variations in crustal thickness on the assumption that the crust floats upon the mantle. That this concept in gross form is substantiated by the seismic measurements is shown in Figure 3, representing a compilation of gravity and seismic data in the same areas from different parts of the world. From Figure 3 and the results of laboratory and field measurements of the seismic velocities and density values associated with different kinds of rocks, we can reach the following general conclusions concerning the crust: (1) the crust has a mean density of about 2.86 gm/cc, and the underlying mantle a density of about 3.32 gm/cc; (2) the crust does appear to float upon the mantle; (3) the surface elevation is directly related to crustal thickness, and the freeboard to root ratio for average crustal conditions is about 1:6.7. There are, however, significant departures from these over-all generalizations. For example, we know that the crust does vary in mean density from the normal value of 2.87 gm/cc over fairly large areas. Where the density is greater than normal, the surface elevation is less and the crustal thickness greater than normal. Conversely, where the mean density is less than the normal value, the surface elevation is higher and the crustal thickness less than normal. These conclusions have been demonstrated by both seismic measurements and the analysis of associated gravity data. The cause for these departures in crustal composition are as yet not understood, and they do not appear to be related to observable surface-geologic features except in the case of granitic batholiths which appear to be characterized by both a subnormal density and seismic velocity.

Regional Versus Local Isostatic Compensations

Another factor associated with the crust beside its thickness and composition is its strength and ability to sustain variations in load associated with local changes in topography. In this connection, it is useful to think of the crust as

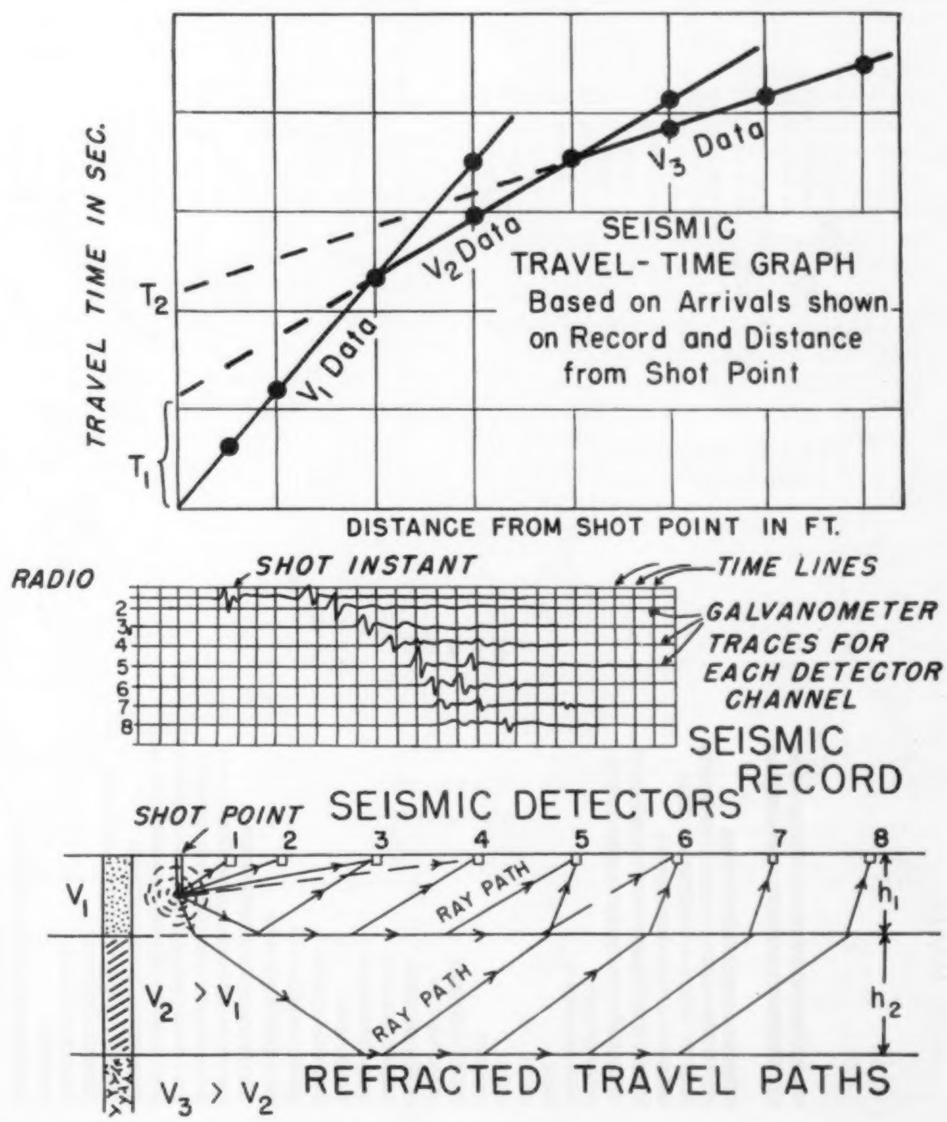

FIGURE 2. Seismic travel-time plot, seismogram, and depth section.

being like a sheet of ice on a lake. When one steps out on a sheet of ice over a lake it frequently can be seen to bend down like an elastic sheet. The ice does not break although it is obviously deformed over a wide area by our weight. This constitutes regional isostatic compensation as the added weight is in part carried by the strength of the ice and in part displaces the underlying water over a wide area. If the strength of the ice were exceeded and the ice broke, however, one would end up floating in the underlying water. This would constitute local isostatic compensation as now one's weight is sustained only in terms of the density differential between ourselves and the water, with our head representing free-board topography and the rest of our body the compensating root. Although local compensation applies to all major topographic features, there are many smaller features, such as the Bighorn Mountains of Wyoming, that appear to be regionally compensated and without underlying roots. Although such areas can be recognized from analytical studies of gravity data, present knowledge of the strength of the crust is still too limited to permit one to gauge exactly how much load can be sustained through regional compensation rather than through local compensation. A rough rule of thumb, though, is that if the width of the topographic feature does not exceed three times the probable thickness of the crust for the region as a whole, it is probably regionally compensated.

Physical-Chemical Relations

Another phenomenon of interest that is related to the crust is that in many areas, such as the Gulf Coast, the deep exploration work for oil indicates that here there has been an accumulation of about 50,000 feet (15 kms) of sedimentary rock material—sand, silt, and mud. As the structural attitude of this material shows that the Gulf Coast area has been progressively sinking as the material was deposited, one is confronted with the problem of how 15 kms of material can be added to the top of the crust and have the surface sink instead of rise as would be predicted from Archimedes' principle. Obviously the crust must be mechanically deformed in such areas or some phenomenon is operative that results in a thinning of the crust by attrition at its lower boundary that keeps pace with the addition of material at the surface. One theory that has been proposed in connection with the latter explanation (Kennedy, 1959) is that the mantle material immediately beneath the crust is composed of the rock eclogite and that the basal portion of the crust is composed of basalt. Eclogite can undergo a reversible polymorphic phase transformation to a lower density form which is basalt, with changes in either temperature or pressure. The addition of surface sediments under this hypothesis increases the pressure and automatically thins the crust by inducing the reverse of this transformation. One area where it should be possible to test this hypothesis on a continental-wide scale is Antarctica, where the superimposed load of ice is the equivalent of over one km of sedimentary rock material.

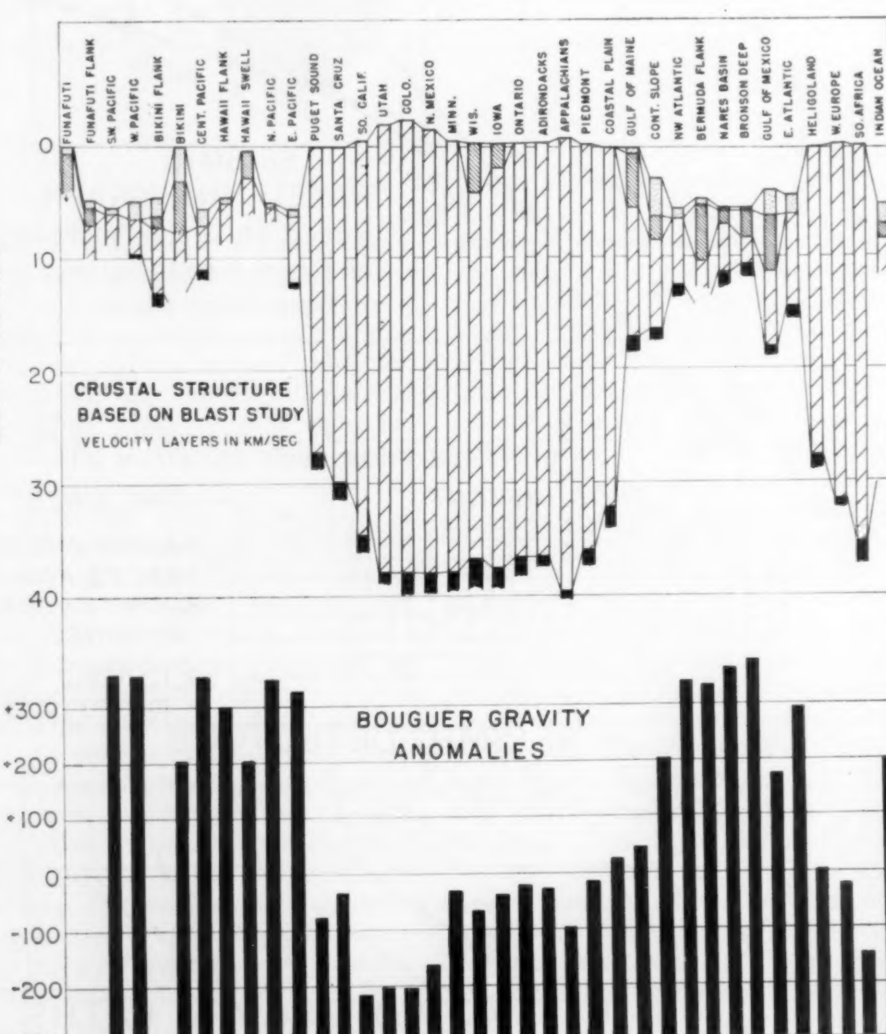

FIGURE 3. Seismic sections of crust and related Bouguer gravity anomalies.

Another physical-chemical phase transformation that has been considered in connection with the crust is the transformation of the high-density rock peridotite to the lower density form serpentine, on the assumption that the mantle material is composed of peridotite. This transformation, which is also reversible, is dependent upon the addition of water and a temperature of less than 500°C. It has been proposed (Hess, 1955) as an explanation for the long-term rise of plateau regions, such as the Colorado Plateau where the incised meanders of the Colorado Canyon suggest that the surface has risen over a mile in recent geologic time.

Instability of the Crust

It is clear from the evidence of the surface geology that the continental crust has not only been subject to tremendous upheavals, fracturing, and horizontal movement, but also periods

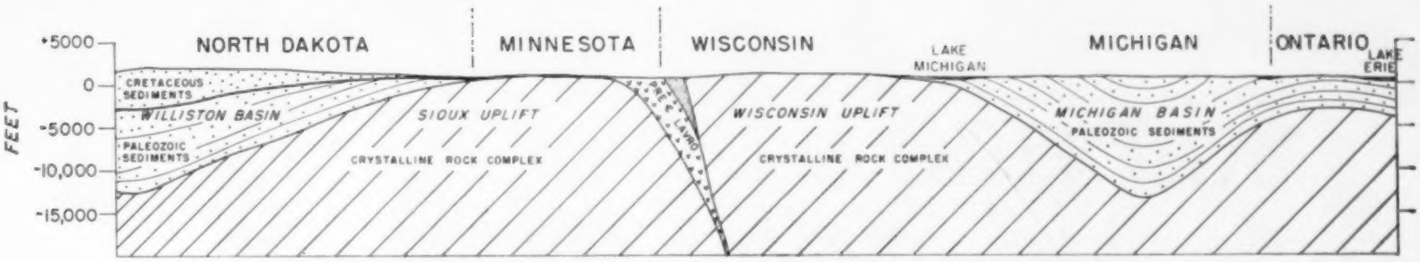

FIGURE 4. Geologic section from North Dakota-Canadian boundary to Michigan-Ontario boundary.

of subsidence allowing great inundations of the seas. Some areas, as Wisconsin, appear to have had almost a continuous history of domal uplift over the past 400 million years. Adjacent areas, as the peninsula of Michigan and Illinois on the other hand, have had a history of almost continuous subsidence. Figure 4 shows the difference in level of the crystalline rock surface on a line from North Dakota across Minnesota, Wisconsin, and Michigan. The explanation for these differences in crustal behavior in adjacent areas is not known. They might be related to vertical convectional flow in the underlying mantle induced by heat flow from the central core of the earth. Such convection currents conceivably might pile up crustal material at points of downflow and thin the crust at points of upward and outward movement, or have the reverse effect in bulging the crust upward over points of upflow and dragging it down at points of downflow. The latter explanation has been advanced by Ewing (1960 Vetlesen Lecture) to account for the Mid-Atlantic Ridge which extends almost the entire length of the Atlantic Ocean.

That the crust is subject to large-scale torsional forces which have been a dominant horizontal component that presumably are also related to movement in the underlying mantle is evidenced by the pattern of the world's earthquake belts. These show areas of localized shear and horizontal movement which in the case of California has resulted in a gross displacement of over 150 miles northward of the coastal area relative to the rest of the continent in recent geologic time. In Japan the evidence is that the coastal area is moving to the south. These observations, therefore, suggest that the entire Pacific Ocean Basin is rotating in a counter-clockwise direction. This appears to be further substantiated, as shown in Figure 5, by the "ring of fire" defined by both earthquakes and volcanic activity that mark the boundary of this, the earth's largest crustal feature.

Conclusion

In conclusion it can be said that the problems of the crust are many, and our knowledge of the basic phenomena related to it is still so limited that crustal study can be expected to remain an intriguing branch of scientific study for some time to come. Perhaps when we know more about the crust we shall be able to unravel the problem of the origin of the continents and the ocean basins. At the moment, the theories on the origin of these features range from one having a primordial oceanic crust with the continents growing by accretion from nuclei of oceanic volcanic islands to major variations in crustal thickness being the result of convectional flow on a gigantic scale at an early stage in the earth's history. Another problem that might be resolved through further study of the crust is that of continental drift. Certainly the geologic evidence suggests that several of the now existing continents may have been at one time part of a larger mass. The evidence, however, is far from convincing and implies a mobility that is difficult to reconcile with physical theory unless it can also be proved that the earth's crust as a whole is free to migrate as an independent entity about the earth which it encloses.

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FIGURE 5. Distribution of world's earthquakes.

Science as a METHOD OF APPROACH

By FREDERIC B. VIAUX

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I HAVE been impressed by the fact that many high school and college students who exhibit an active interest in science courses are generally absorbed in the factual aspects of the subject matter. They are frequently unaware that science is not subject matter, but rather a method of approaching the study of subject matter in any field.

Biology, chemistry, physics, geology, etc., are called sciences primarily because the nature of their phenomena is sympathetic to the approach of science observation, experimentation, hypothesis development, and the formulation of board conceptual schemes.

In an attempt to bring this aspect home to the students, I have formulated an assignment on photosynthesis, chosen because it is important and a student can easily garner a general knowledge of the process from the data supplied. The assignment has been designed for students who have no knowledge of botany, and it is given to high school biology students before they study photosynthesis. In fact, it is used as an introduction to photosynthesis. If students have a feel for looking at a problem from the point of view of a scientist, they can do quite well with the assignment.

The value of the assignment, however, extends beyond this one application. I asked both the chemistry and physics departments to give it to a cross section of the students in their classes who have had no botany or biology. The English or history teachers also gave it to some of their students. Because it is, after all, an exercise in disciplined thought, the students who perform most adequately are those who have developed the habit of rigorous mental application regardless of their subject-matter interest.

Similar assignments can be developed in such areas as heredity, the kinetic theory, or the Young-Helmholz theory of color vision. If you try this project in your classes, please write the author and share your results.

Interpretation of Experimental Results

EXPERIMENT A

One leaf from each of two similar, well-watered geranium plants was tested for starch. The leaf from Plant A, which had been kept in the dark for 24 hours, contained no starch. The leaf from Plant B, which had been in bright light for 24 hours, contained much starch.

EXPERIMENT B

A variegated leaf (one which is white and green) was removed from a healthy, well-watered plant which had been in the bright light for 24 hours and tested for starch. It showed heavy starch deposits in the green part of the leaf but little in the white part.

EXPERIMENT C

A healthy, well-watered geranium plant was placed in the dark for 24 hours; then it was removed and the upper surface of Leaf A was coated with vaseline; the under surface of Leaf B was coated with vaseline; and both surfaces of Leaf C were coated with vaseline. The plant was placed in bright light for 24 hours and then leaves A, B, and C, and an uncoated Leaf D were tested for starch. Leaf D had the most starch; Leaf A, good starch deposits; Leaf B had very little starch; and Leaf C had none.

EXPERIMENT D

Two healthy geranium plants were placed in the dark for 24 hours. Plant A was normally watered. Plant B had not been watered for two weeks and the soil

was dry. Both plants were then placed in the sun for 24 hours and a leaf from each tested for starch. The leaf from Plant A showed heavy starch deposits. The leaf from Plant B showed none.

EXPERIMENT E

Both the upper and under surface of a leaf from a healthy, well-watered geranium plant were examined carefully under a microscope. It was observed that there were a few scattered openings or pores in the upper surface of the leaf and a large number of similar pores on the under surface.

EXPERIMENT F

A healthy, well-watered geranium plant was placed in the dark for 24 hours and then removed. One healthy, exposed leaf was gently twisted on its petiole (stem) so the under surface was up. It was held in this manner so it could not twist back. No damage was done to the leaf or the petiole. After 24 hours, the inverted Leaf A and another healthy exposed Leaf B were tested for starch. Both showed starch deposits, but the deposits were markedly heavier in Leaf B.

Answer the Following Questions

1. What is the variable in Experiment A?
2. In which of the two experiments is there one common variable?
3. The observations in Experiment C are possibly explained by the observations in which experiment?
4. What is the one basic variable in Experiment C?
5. The observations in Experiment F may possibly be confirmed by the observations in which experiment?
6. Which plant is the control in Experiment C?

A hypothesis is an idea which you think might be the true explanation of an observation or a result. With a hypothesis you can predict what might happen under various circumstances and then test your prediction experimentally to see if your hypothesis is correct. In each of questions 7 through 11, you will be asked to make a hypothesis from the results of some of the experiments. In each case tell why the results lead you to the hypothesis you stated.

7. Develop a hypothesis to explain the results of Experiment A.
8. Develop a hypothesis to explain the results of Experiment B.
9. Develop a hypothesis to explain the results of Experiment C.
10. Develop a hypothesis to explain the results of Experiment D.
11. Develop a hypothesis to explain the results of Experiment F.
12. A conceptional scheme or theory is made from weaving together related hypotheses into a logical system which can, or should, explain a complicated process. If the theory is a good one, you can predict what will happen in or to the process under a variety of circumstances. You can then create the various circumstances in the laboratory and see if your predictions are confirmed. If they are, your theory is a good explanatory, working tool and will remain so until you strike a circumstance which the theory will not explain. Then you must either modify or discard your theory. Generally, if the theory has proved useful, it is at least partially correct and will be modified rather than discarded.

With the foregoing in mind, study the hypotheses you have made in answering questions 7 through 11, and then construct a theory of starch formation by plants which will explain the process and permit you to predict results of experiments dealing with the production of starch in plants. In answering this question, you must stick to the experimental results offered in the six experiments for these are the only pieces of evidence you have. Now, if you wish to use your imagination and general knowledge of the process to add to your theory, you are encouraged to do so, but in your writing be sure you distinguish clearly between which statements result from the observations made on the six experiments, and which statements are imaginative projections suggested by the results.

Optional Question for Extra Credit

Make an assumption using your imagination and/or general knowledge about an important factor in the production of starch suggested but not proven by Experiment C. Then briefly outline an experiment which you think would test the validity of your assumption. Your assumption does not have to be correct. You will be graded on the manner in which you present your assumption, the reasons you think it is important, and the imagination and care with which you plan your experiment to test the assumption.

The Future Scientists o

A N   N S T A   S T

THE first year of the 1960 decade promises to be a momentous one for the National Science Teachers Association—and for all "science-prone" students and their teachers. The inauguration of the Future Scientists of America (FSA), an activity of NSTA dealing with services, materials for teachers, and club-type organizations for students, will be accomplished in September 1960. The initial offerings of FSA will include:

► The chartering of school science clubs as chapters of FSA.

► A sponsor's guide for teachers containing suggestions for operation of an FSA chapter and appropriate related activities that confront a science teacher during the year.

► A quarterly newsletter published by FSA containing news and describing work that is taking place in the FSA chapters.

► A chapter charter or plaque for the school, and membership cards, pins, and other insignia for students.

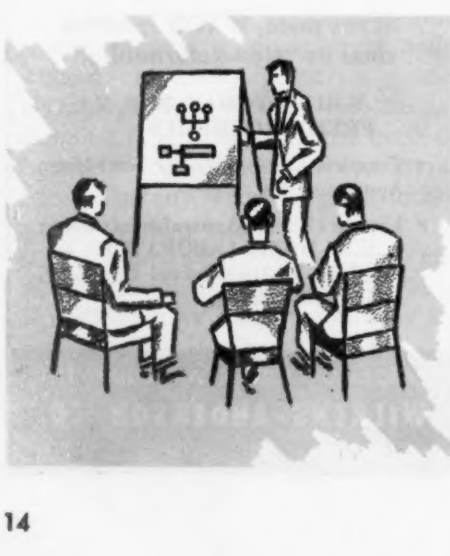
► A "Vistas in Science" series taking the general format of paperback books, each consisting of a historical review, an approach to research, and a student project section within a particular science discipline.

► Suggestions for the operation of a youth science congress in which students meet to present papers about work they have accomplished individually during the year.

The FSA organization was established after nearly four years of intensive study by NSTA through its Future Scientists of America Foundation. It will function as an extracurricular student activity open for membership to all secondary schools in America. At the suggestion of the Future Scientists of America Foundation Administrative Committee and NSTA Standing Committee I (Science Education Activities for Youth), a steering committee comprised of practicing science teachers will be established to assist in guiding further development and administration of the Future Scientists of America program.

Along these same lines, a group of science teachers, science educators, supervisors, superintendents, and other interested persons in the science field have been drawn together as a "sounding board" to aid in establishing the validity of suggested future plans and ideas for the expansion of the FSA. The title given to this group is the Field Advisory Board (FAB), which now has 150 members.

Through suggested activities, services, materials, and club-type activities, FSA aims to assist the teachers of America in locating and nurturing able and interested students who have the potential to become productive in the scientific endeavor. It is the desire of FSA to cooperate in every possible way with all existing youth programs in science such as state junior academies of science, state talent searches, summer institutes for high school students, and others.



The cost of affiliating an FSA chapter will be based on the total school enrollment which supports the chapter. For example, two or three small schools may find it desirable to cooperate in forming and sponsoring a single chapter of FSA. Larger schools, of course, will have their own school chapters.

The initial chartering fees for various categories of school populations are as follows:

0-300	$5
301-1000	$8
over 1000	$10

The yearly charter renewal fees have been set at these figures:

0-300	$2
301-1000	$3
over 1000	$4

These fees were established after

s of America Program . . .

AFF REPORT

considerable study of the cost patterns of other comparable youth organizations and on best estimates of actual costs to NSTA of providing the projected FSA services and materials.

Earlier, we mentioned the sponsor's guide or handbook. A copy will be presented to sponsors of all chapters upon completion of official charter requirements. A tentative content outline for this guidebook was established by a group of teachers at the NSTA convention in Kansas City in 1960. This outline was submitted to the Field Advisory Board for recommendations, suggestions, additions, deletions, and revisions. After tabulation was made and the content decided upon, the writing of the actual manuscript needed to be accomplished. To achieve this, the NSTA followed a rather unusual but highly effective approach. In discussing the guide, it was felt that one of the most important factors was to have a guide *written by and for classroom science teachers* who realize the materials and services most needed. The most expedient way to achieve this end was to appoint a group of writers to meet and prepare the rough-draft manuscript which would eventually become the FSA sponsor's guide. This writing team consisted of seven members: Harry K. Wong, teacher of biology, Menlo-Atherton High School, Atherton, California; Nellie McCool, teacher of science, Highland View Junior High School, Corvallis, Oregon; Harry Packard, doctoral candidate, School of Education, University of North Carolina, Chapel Hill; William Powell, teacher of chemistry, Edwardsville High School, Edwardsville, Illinois; Edward Beach, Administrative Assistant, Department of Education, Prince George's County, Upper Marlboro, Maryland; Joan Hunter, teacher of biology, West Senior High School, Aurora, Illinois; and Kenneth B. Hobbs, Executive Secretary, Ohio Academy of Science, Columbus, Ohio. This group met and wrote a preliminary edition of the guide from June 17 to 23 in Washington, D. C.

A work of this nature must be kept up to date, and in order to facilitate this, a summer work conference of representative FSA sponsors in 1961 is already in the planning stage. The ramifications of such a meeting could be many. An interchange of usable ideas and acceptable practices from one chapter sponsor to another would seem inevitable under these conditions.

One of the most important facets of the FSA will be a quarterly newsletter, *The FSA Centrifuge,* through which communication among chapters and even individuals within the chapters will be encouraged and transmitted. As with any newsletter, the main topics for discussion here will be operation,

structure, news, and events about the various chapters of FSA. *Science World,* a publication of Scholastic Magazines, Inc., is continuing to publish "Tomorrow's Scientists" as a portion of its content through the 1959 agreement with the NSTA Board of Directors. This is a publication in which a student may have a piece of his own work appear in print with a personal by-line—a very gratifying experience for a high school student.

A set of materials for sponsors will accompany the issuance of an FSA charter. Included in these will be a plaque of unique and colorful design, a group of membership cards for students, a sponsor's guidebook and a listing of a modest array of FSA pins and insignia for those who desire them.

Another promising segment of the FSA operation is the production of the publication series under the general title of "Vistas in Science." Each book will be concerned with a specific area of science such as cell physiology, biochemistry, herpetology, oceanography, and metallurgy. These books will contain three sections: first, a brief presentation of the discipline or field to be investigated; second, research methods and problems in the area; and third, suggestions for student projects relating to the particular field. Projects will vary from a simple, directed type in which almost all instructions are given to a complex, open-ended type in which instructions are limited to virtually nothing more than a thought-provoking problem.

The "Vista" series will be one of the many services rendered without additional cost to the FSA chapters. Each FSA chapter will receive one copy of each title as it is published.

Plans call for the first of these to be off the press early in 1961. The "Vista" series will be published, advertised, and marketed by Scholastic Book Services of Scholastic Magazines, Inc., through their "Science Book Club" for youth.

The writing of the planned publications involves considerable effort on the part of many people. One such group is the "Vistas in Science" Editorial Board composed of the following individuals: Frederick Fitzpatrick, Professor of Science Education, Teachers College, Columbia University, New York City; Sister M. Gabrielle, Principal, Holy Trinity High School, Hartford, Connecticut; Mason Boudrye, Executive Secretary, Minnesota Academy of Science, Minneapolis, Minnesota; Robert D. Binger, Supervisor of Science, State Department of Education, Tallahassee, Florida, Graham DuShane, Editor of *Science,* American Association for the Advancement of Science, Washington, D. C., and Hugh Odishaw, Executive Director, IGY, National Academy of Sciences, Washington, D. C. This Board will govern the entire project, and at least one member of the Board will work directly with the writer and committee to produce each individual "Vista" publication.

Youth science congresses have been of great value in many sections of the country. In conjunction with FSA, it is now planned to run a pilot study of such congresses in various parts of the United States within the next year or two. If these tryouts prove favorable, state and regional youth science congresses may be incorporated into the operations of FSA.

A youth science congress gives the individual student the opportunity to participate in an experience which is similar to that of our practicing scientists. This would emphasize writing, reporting, and physical presentation or speaking on the part of the person involved. Such symposium endeavors should also stimulate a lasting interest in the basic processes of scientific inquiry.

For nine consecutive years the NSTA has successfully conducted a student science awards program called the Science Achievement Awards for Students (SAAS). An amalgamation of this annual activity into the new FSA program will be most desirable. However, some changes will be incorporated in 1961. For example, the name will be changed to the Future Scientists of America Awards, and henceforth the program will be an integral part of FSA. Last year there were approximately 6300 entries in this science awards contest, and the number should increase this year. Materials and information concerning the 1961 program are currently available from NSTA, 1201 Sixteenth Street, N. W., Washington 6, D. C.

The forming of an FSA chapter can be accomplished in many ways. A single school or a group of schools may participate. Even an interested group of students outside of an actual educational plant may participate in this program if other acceptable adult sponsorship can be assured. The purpose of this new organization is to assist the sparsely populated regions of the country which contain small schools with insufficient numbers of students to organize individually an effective chapter of FSA.

Many other activities are contemplated for the evolving FSA program. These may include, for example, the production of guidance career films, a U. S. Youth Registry for Achievement in Science and Mathematics, and possible summer conferences for FSA student leaders. The registry would be an accumulation of names of science students throughout the United States based on state, regional, or national achievement, or those who have been recognized as highly capable students. For example, selection of a student for one of the National Science Foundation summer institutes will make him eligible for placement on the registry. The reason for establishing such a registry is that it will produce a reservoir of identified science talent correlated with extracurricular activities and achievements in science. Another main objective is to bring together meritorious students and the admissions officers of colleges and universities having special programs or scholarships in science.

The FSA youth program with its services to teachers and club activities for students is an ambitious undertaking for the NSTA. This operation was spearheaded by science teachers throughout the United States when a questionnaire and opinionnaire were circulated by NSTA to approximately 15,000 classroom science teachers asking for help in establishing directions and making decisions about this new youth organization. The results proved to be favorable, since the science teachers expressed the opinion that such an organization was not only feasible, but also bady needed.

In the summer of 1959, having compiled the advice and experiences of over 2000 scientists, science educators, science teachers, supervisors, superintendents, and other interested persons directly connected with education and youth organizations, the NSTA Board of Directors approved the general plan for an FSA program. At this meeting also, the appointment of a Director of Youth Activities was authorized, and Mr. William P. Ladson joined the NSTA staff on February 15, 1960 in this capacity. Mr. Ladson was formerly head of the Science Department at Groveton High School in Fairfax County, Virginia, and has a wide background of association with youth activities, professional organizations, and science institutes. (See "NSTA Activities," *The Science Teacher,* February 1960. p. 54.)

The FSAF Administrative Committee and the NSTA Board of Directors authorized Dr. Zachariah Subarsky, Coordinator of Special Science Activities at the Bronx High School of Science in New York City, to guide the preparation of an operational plan for the Future Scientists of America. At the Board of Directors 1960 annual meeting in Los Angeles, California, the specifications for the operation of a Future Scientists of America program under the auspices of NSTA were authorized.

The FSA is ready to go. All of the organizational preparations and procedures have been accomplished. The materials and services to assist you in your task of locating and nurturing the interested and motivated students into science fields have been prepared. The FSA program was designed by science teachers, inaugurated by science teachers, and will be improved through the suggestions of science teachers. We urge the science teachers to offer constructive criticism about the program, its administration, services, and materials. We can assist you only when we are aware of your desires regarding this program.

The success of FSA depends on the enthusiasm of *you,* the science teacher.

RADIOSONDES

Flying Saucers in the Classroom

By RALPH O. MOLL

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and FRED W. DECKER

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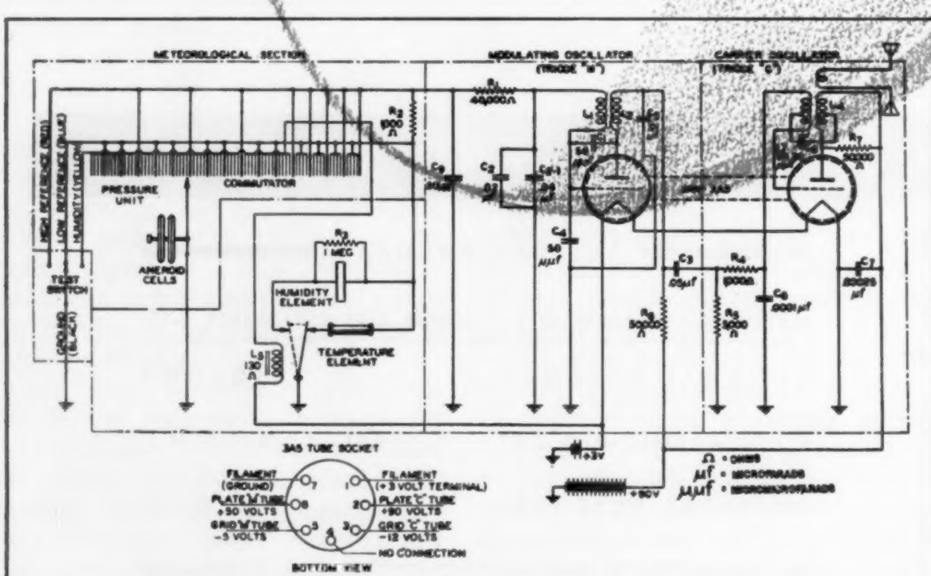
HAS a student ever brought into your classroom a cardboard or plastic box of electronic equipment, perhaps with bits of parachute and balloon still attached, which he found on the street, in a field, or in the forest? If so, you at that time probably met the radiosonde, an instrument which is released at least twice daily at some 60 weather stations in the United States. Ascending to heights of around 20 miles in the atmosphere, the balloons which carry these instruments are often mistaken for "flying saucers" as they probe the upper air. The radiosonde is a tiny radio transmitter with its own power supply. Sensing elements modulate its signal, which fluctuates to indicate the temperature, humidity, and pressure of the upper air. The surface-receiving equipment at land stations usually includes an automatic direction finder which tracks the balloon-borne transmitter and thus charts the motion of the balloon caused by the upper winds. The entire system records the essential information at various levels as required by meteorologists for upper air analysis and forecasting.

Few teachers are able to give a classroom demonstration of an earth satellite, but no one should encounter trouble in demonstrating the device which probes the upper air between the earth and outer space. Even if a student does not bring a radiosonde to class, the teacher can still purchase an obsolete radiosonde from an electronic surplus dealer. In this article the function of the radiosonde is explained to show how various models can be displayed and demonstrated in a classroom. Suggestions are given for follow-up action for students who show signs of career interest in atmospheric science.

The essential features of the radiosonde include the carrier oscillator, the modulating (blocking) oscillator, the battery pack, and the sensing elements for temperature, pressure, and humidity. Examination of a radiosonde will reveal the carrier oscillator connected to its antenna.

The prewar radiosondes, which were superseded at land stations beginning in 1943, operated at 72 mc and had two antenna wires about three feet long extending upward and downward from the transmitter. During the war and for more than a decade since World War

FIGURE 1. Radiosonde AN/AMQ—Schematic diagram of circuit.



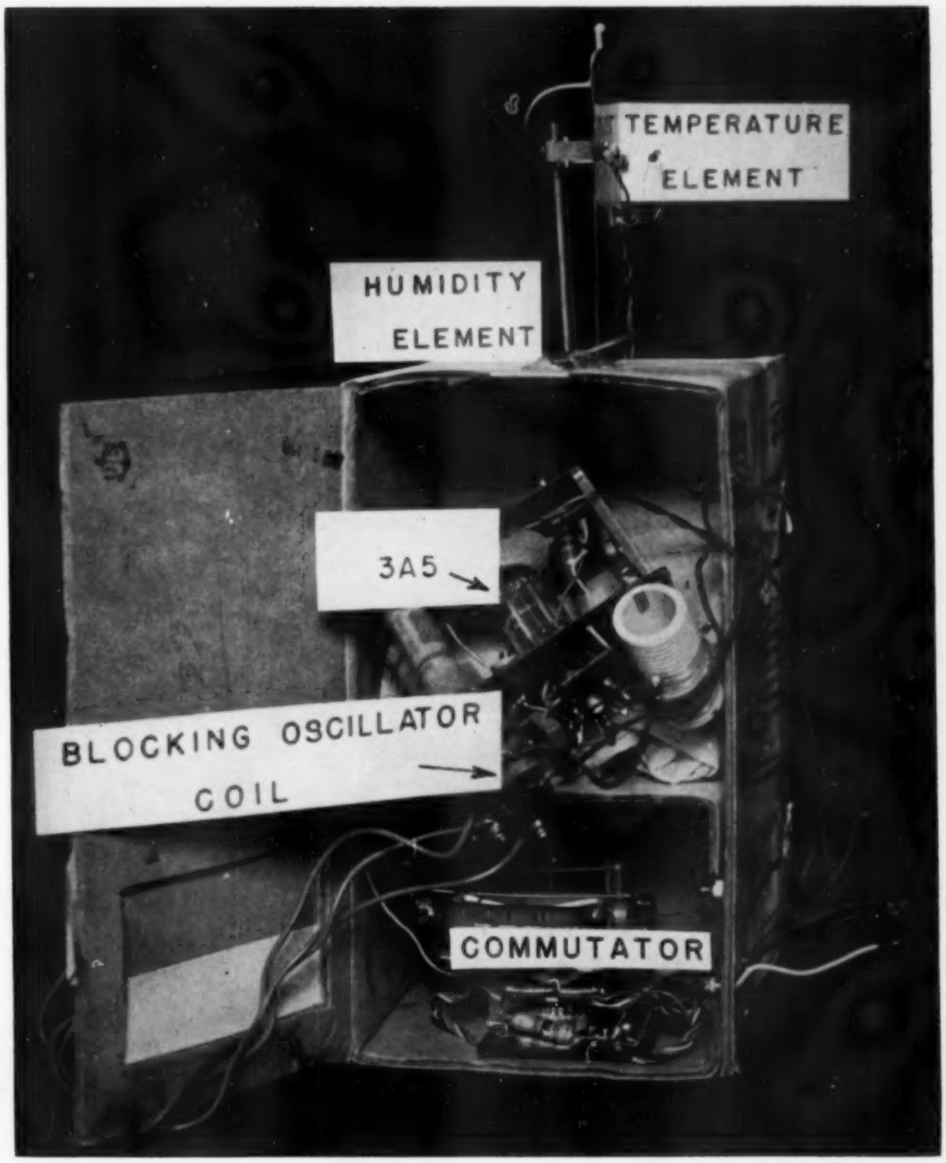
II, many U.S. stations have used a 403-mc transmitter with a much shorter antenna in the flight equipment. The U.S. Weather Bureau is replacing this system with the 1680-mc radiosonde that has an antenna only a few inches long. For a number of years the military services have been using the 1680-mc system which includes an automatic tracking round-station direction finder.

Surplus retailers advertise the 72-mc radiosondes at nominal prices, and occasionally one released from a ship at sea may drop on land. The other instruments are more likely to be available either as discards from a weather station or as recovered flight equipment after descent.

In some radiosondes the same glass envelope contains the blocking oscillator and the carrier oscillator electron tube elements which are included in the "one-tube" 72-mc unit. In others separate tubes perform this function. If you have a unit which is not included in Table I of this article, a small amount of electronic exploring will locate the blocking oscillator coil. This coil tunes the blocking oscillator to a frequency in the region of 250 to 1500 kc. The oscillations, however, halt periodically at a rate determined by the resistance between grid and cathode in the blocking oscillator circuit. In the radiosonde a pressure-actuated commutator switch connects this resistance into the circuit by selecting one of several resistors, including the two fixed reference resistors and the temperature and humidity sensors. An aneroid barometer operates the arm of the commutator switch to make it connect one or the other of these resistors into the circuit. A calibration chart provides the pressure at which each switching function occurs.

The temperature element consists of a thermistor or temperature-sensitive resistor. The humidity element consists of a strip of plastic sheet coated with hygroscopic salt and provided with metalized edges between which the resistance varies as a function of humidity as well as temperature.

After a radiosonde has been released at a weather station, the loudspeaker of the receiver provides an audible tone between 0 and 200 cps with abrupt changes of tone as the baroswitch changes the controlling parts aloft. This



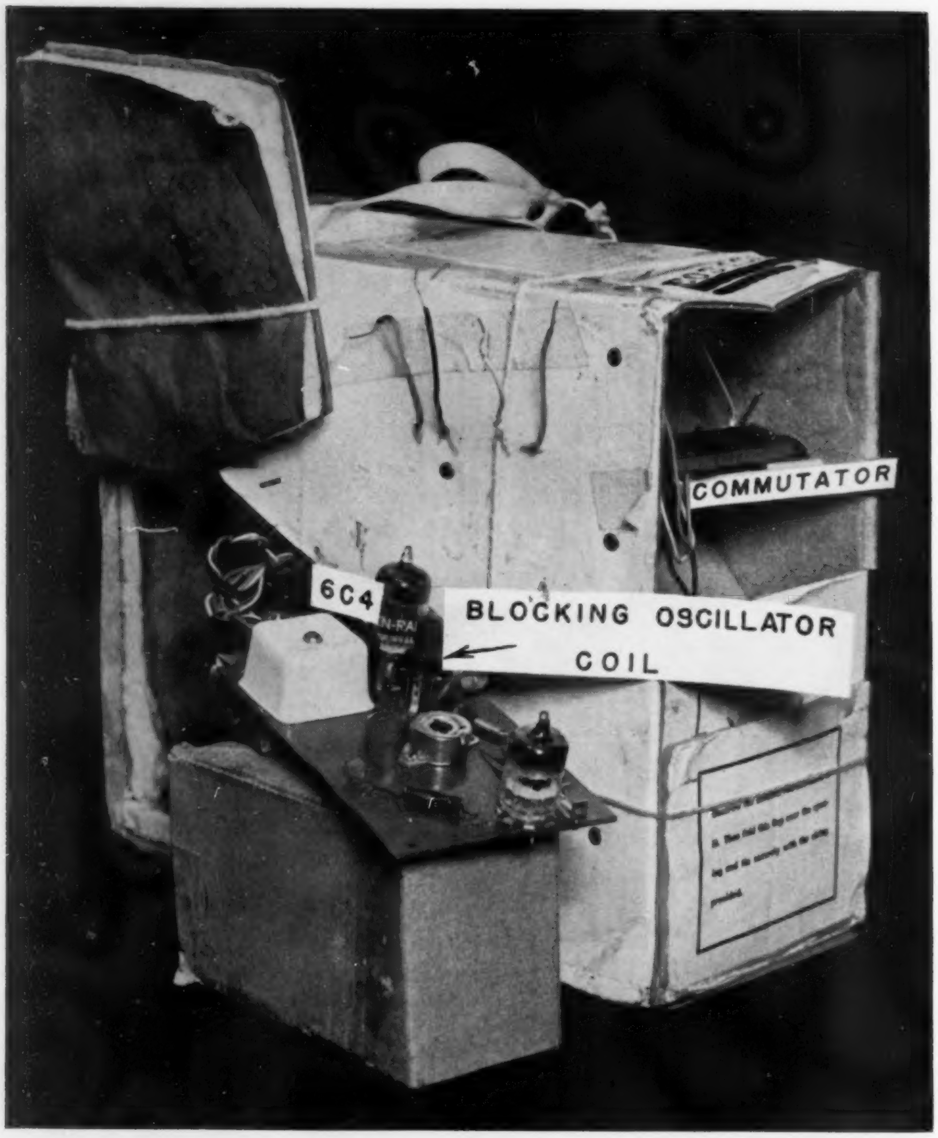
AN/AMQ-1D radiosonde opened to show essential features of the transmitter and sensors.

results from the fact that the blocking oscillator modulates the carrier in much the same way that the microphone and modulator cause a broadcast station to transmit audible signals.

At the weather station the operator performs ground checks on the flight equipment before release by listening to the signal with a receiver tuned to the carrier frequency. Not many classrooms, however, are equipped with receivers which tune to the radiosonde frequency. Although this has deterred those who would like to make a classroom demonstration, the demonstration can be made with a simple adaptation to listen to the blocking oscillator directly instead of to the carrier frequency.

To make the radiosonde audible in the classroom, twist several turns of wire around the blocking oscillator coil and allow a few feet of this wire to dangle near a broadcast radio receiver. A table model radio across the room from the radiosonde can be used to emphasize the radio transmission. To avoid interference to other services from the carrier oscillator, that portion of the circuit can be disabled or the carrier antenna can be removed.

Several typical radiosondes are shown in the illustrations. In each of these the blocking oscillator coil is recognized by the numerous turns of fine wire, usually in successive layers or basket weave, on a small diameter coil form. To transmit the blocking oscillator signal across the room, simply procure about five feet of insulated



U. S. Weather Bureau 403-mc radiosonde showing transmitter parts.

lightweight wire and wrap several turns of this wire around the blocking oscillator coil at the middle of the wire.

Batteries or another power source must be supplied to demonstrate the operation of the radiosonde. Some of the most common models are tabulated in Table I. In case of doubt, however, one can use an ohmmeter to determine which prongs of the battery connector go to filament (low resistance) and plate (high resistance). The battery which is removed from used flight equipment will often reveal both the voltages and the connections necessary for proper operation of the radiosonde. The power may be obtained from dry batteries or from a receiver power supply.

In performing the demonstration, arrange to have a broadcast radio receiver located at a suitable distance in the room. Provide power for the radiosonde. Have a supply of dry ice available. Lift the baroswitch arm from the commutator with the lever provided, or put a piece of insulating material between the baroswitch contact arm and the commutator. Have a flexible wire lead a few inches long provided with alligator clips.

When the transmitter is activated and the blocking oscillator signal is tuned in by the broadcast radio, the audible tone will depend upon temperature. This effect can be demonstrated by holding dry ice near the temperature element and allowing the chilled air to flow over the thermistor. The tone should drop noticeably. Warming the element should raise the pitch.

Now connect the clip lead between the ground wire and the humidity wire among the three short leads which protrude from the side of the box, or connect between the baroswitch arm and the bus lead which connects the groups of four metallic commutator segments together. This will cause the relay to shift to the humidity connection. Blowing on the humidity element will increase the humidity and will raise the audio tone by decreasing the resistance of the surface of the plastic element.

If a bell jar is available, slowly evacuate it and make the instrument inside the bell jar simulate a flight. Here the baroswitch arm should be in contact with the commutator, and the clip lead should be removed. The abrupt alternations of temperature, humidity, and reference tones will be produced just as if the instrument were in flight.

If the external wires are not labeled, the color code is black for ground and yellow for humidity.

The demonstration and explanation of the radiosonde will bring into the classroom abundant material to stimulate interest and imagination. If the experiment is too hastily covered, however, the students will be more bewildered than educated. Consequently, the instructor should first make sure that he has a workable plan for presenting the demonstration to his students. The interest evinced by students will be rewarding.

As a follow up or as a preface to the demonstration, a visit to a nearby weather station will further orient students to the use of the radiosonde. Even if the station does not make these soundings, the data from upper air sounding stations may be available and will provide further perspective on the use which meteorologists can make of this material. In the classroom the instructor can point out that the upper air chart in the lower left-hand corner of the U.S. Weather Bureau's Daily Weather Map is constructed from radiosonde data. The entire system is called "rawinsonde" when upper winds are included.

Some students will want to pursue special study of the electronics of the instrument, and many will gain new insight into the methods and data requirements of modern meteorology.[1]

[1] John A. Day and Fred W. Decker. *Rudiments of Weather*. Second Edition. O. S. C. Cooperative Association, Box 491, Corvallis, Oregon. 1958.

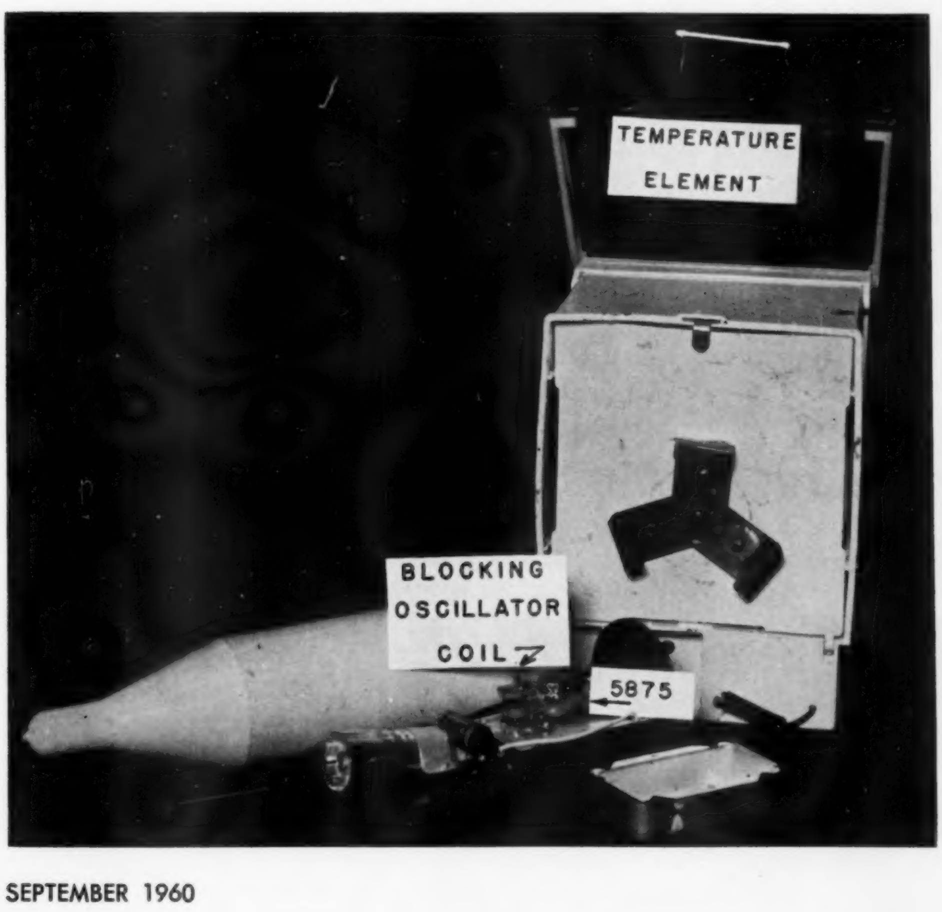
TABLE I

Radiosonde Characteristics

Identification	AN/AMQ-1D	USWB	AN/AMT-4 (T-304)	USWB
Carrier Frequency (mc)	72.2	403	1680	1680
Carrier Oscillator Tube*	3A5 (½)	6AF4G	5794	6562
Carrier Oscillator Filament Wire	yellow	yellow	white	yellow
Volts	3.0	6.3	**	6.3
Blocking Oscillator Frequency (kc)	1000	250	300-350	2500-5000
Blocking Oscillator Tube	3A5 (½)	6C4	5875	6C4
Blocking Oscillator Filament Wire	yellow	yellow	green	yellow
Volts*	3.0	6.3	1.25	6.3
Grid Wire Color	red	—	red	—
Plate Supply Color	blue	red	blue or yellow	red
Plate Volts	90	90	90	110
Ground (Common) Insulation	black	black	black	black

* Where one model used a 1G6 tube, the filament voltage supplied was 1.4 volts.
** Where a separate connection is made for carrier oscillator filament, this is left unconnected to avoid unnecessary radiation.

AN/AMT-4 radiosonde details.



Special Report . . .

A STUDY OF THE RELATIONSHIP BETWEEN SUBJECTS TAKEN AND OTHER SELECTED FACTORS FOR THE CLASS OF 1958, MARYLAND PUBLIC HIGH SCHOOLS

Prepared by ORVAL L. ULRY

THE most comprehensive survey of the programs and subjects taken by Maryland public school students was released recently by the Maryland State Department of Education. This survey involved virtually all of the 17,000 students of the 1958 graduating class of the public high schools in the state. Information included all subjects taken and reasons for taking, or not taking, certain "academic" courses during the four-year high school program.

The project was undertaken jointly by the University of Maryland, the State Department of Education, and the twenty-four local school systems largely because of a growing concern over the shortage of manpower in scientific and technological fields and the increasing public interest in educational matters. An academically talented phase of the study was developed in cooperation with Dr. James B. Conant as a part of his nation-wide study.

Mr. Paul Huffington of the State Department of Education and Dr. Orval L. Ulry, Director of Summer School, University of Maryland, were responsible for the over-all planning and coordination of the project as well as the preparation of the report.

Specifically, this study was undertaken to provide information relating to such questions as:

1. Are "difficult courses" offered in the Maryland public high schools?
2. Are graduation requirements sufficiently rigorous?
3. Do the Maryland public high school students pursue too many subjects of a superficial nature?
4. Are the academically talented students taking the so-called "solid" courses?
5. Are the Maryland public high schools adequately preparing their graduates for college?

Since this study was the first of this nature to involve the graduating class of each of the public high schools in Maryland, certain other related data were gathered. These included age, units earned for graduation, IQ scores, post-high school plans, type of diploma received, and reasons for program choice.

From the basic data certain tabulations of related information seemed relevant. These combination tabulations included:

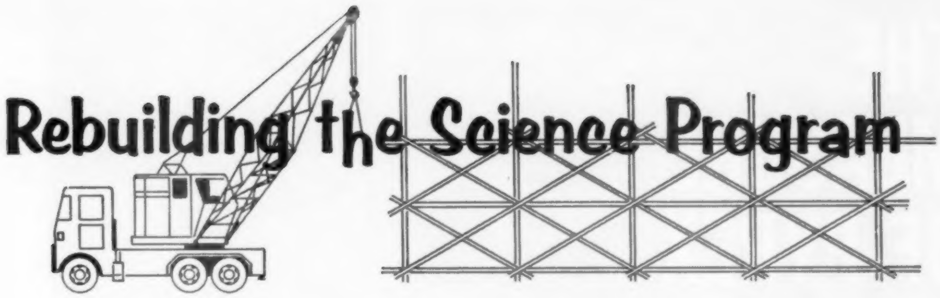
1. Type of diploma received related to units earned for graduation.
2. Type of diploma received related to post-high school plans.
3. Reason for program choice related to type of diploma received.
4. IQ score related to type of diploma received.
5. IQ score related to post-high school plans.
6. IQ score related to reason for program choice.
7. Post-high school plans related to reason for program choice.

The findings of this survey definitely refute much of the current criticism that is being leveled against public education today. Students in the public schools in the State of Maryland do have opportunity to take "difficult" subjects and do, in fact, pursue them. The data provide positive evidence that the students surveyed did enroll in courses generally consistent with their abilities, interests, and post-high school plans. Sixty-three per cent of all the seniors surveyed had taken Algebra 1; 46 per cent had pursued plane geometry; 90 per cent had chosen biology; 42 per cent had enrolled in chemistry; and 39 per cent of the boys had studied physics.

The survey further reveals that approximately three out of five graduates earned twenty or more units for graduation, even though only sixteen units are required. Since Maryland is in that group of states having the most rigid and explicitly stated graduation requirements, certainly the criticism that these students are not earning a sufficient number of units for graduation is completely unfounded.

Another major finding reveals that Maryland high school students pursued courses quite appropriate to their post-high school plans. Of the four major program offerings, the largest single group of students pursued the academic courses. This is consistent with the significant fact that nearly one-half of the total number of graduates indicated a desire for further education.

Approximately one student out of twelve surveyed had an IQ of 120 or above and was labeled as academically talented both for this report and for the "Conant Report." If only the academically talented students are considered, the survey findings are even more significant. These data show that a great majority of the academically talented students in Maryland high schools are taking balanced and intensive programs which should provide a thorough foundation for successful college work. For example, the study reveals that in the field of science, 85 per cent of the boys and 68 per cent of the girls took chemistry, while courses in physics were completed by 79 per cent of the boys and 38 per cent of the girls. In mathematics, 91 per cent of the boys and 66 per cent of the girls earned three units of credit in college preparatory mathematics.



Science Teaching in Small Central Schools

By CHARLES H. HEIMLER

Chemistry Department Coordinator, Orange County Community College, Middletown, New York

THE results of a recent study of the teaching of science in small New York State central schools may be of interest and benefit to those classroom teachers and science educators who are involved in the improvement and development of secondary school science programs in small high schools.

The purpose of the original study was to determine the status of science teaching in small central schools and to prepare a list of the instructional problems encountered by the science teachers. This information was then used as a basis for the development of a guide for the improvement of science teaching in these schools.[1]

The method consisted of the gathering of information through a questionnaire that was distributed to 529 science teachers in 249 central schools having a student enrollment of less than 400 pupils in grades 7-12.

Questionnaires were returned by fifty-five per cent of the teachers employed in seventy-eight per cent of the schools. The data provided on these questionnaires were then reviewed and tabulated by the author. A summary of this information, indicating the present status of science programs and the problems of the science teachers, is given below.

Organization of the science program: 1. All of the schools offer general science, biology, chemistry, and physics. Thirty-two per cent teach earth science, six per cent teach physical science, and about one per cent teach applied science or advanced science.

2. Sixty-six per cent of the schools alternate chemistry and physics on a yearly basis.

3. Seventy-one per cent of the schools have a science laboratory and classroom combined together. The most common room size is from 600 to 1000 square feet.

4. The provision of a separate room for laboratory preparation or the availability of a student project room is the exception. Sixty-seven per cent of the schools do not have a preparation room and ninety-two per cent do not provide a room for student projects.

The science teacher: 1. In general, the science teachers employed to teach senior high school science are well prepared in science education and in at least one science subject. About one-fourth of the teachers, however, had either emergency or provisional certificates, or no certification at all. Lack of permanent certification was more common with junior high school teachers than with senior high school teachers.

2. An interesting aspect concerning the background of science teachers is the great variety of undergraduate college majors represented by the group. Twenty-seven different college majors were represented. One-half of the science teachers had been undergraduate college science majors.

3. Sixty per cent of the teachers had completed a science methods course and a course in practice teaching.

4. About one-third of the science teachers had only one to two years of experience in their present position.

5. A typical science teacher is scheduled for five to six class periods, one free period, one study hall, and a homeroom class.

Teaching methods: 1. Methods of teaching science consisted primarily of the lecture-demonstration, class discussion, laboratory work, and the completion of textbook assignments.

2. The lecture-demonstration was rated as the most effective method.

3. About half of the senior high school teachers consider laboratory work as an effective method, whereas only thirteen per cent of the general science teachers held this opinion.

4. Only one-third of the general science teachers stated that they provide laboratory work. Seventy-four per cent of these teachers consider laboratory work to be a practice in which the teacher performs an experiment and the student records the data in his notebook. Ten per cent of the teachers stated that they provide opportunities for students to plan their own experiments.

5. Laboratory work consisted of carrying out directions provided in published laboratory manuals or mimeographed material which were provided by the teacher.

Science course subject matter: 1. The content of the science course is determined primarily by the state syllabus, textbook, and the Regents examination.

2. Most science teachers prefer organizing their course content as a logical arrangement of subject matter or a type of organization based on major science concepts and principles.

3. Although the number of textbooks in use is large, the number of textbooks used by eighty to ninety per cent of the teachers is few. For example, four different textbooks are used by eighty-one per cent of the general science teachers and five textbooks by ninety-two per cent of the physics teachers.

4. Less than one per cent of the teachers use a multiple textbook program.

Equipment: 1. Most teachers felt that their schools are well furnished with the basic laboratory equipment necessary for a minimum program. Many junior high school teachers, however, reported a lack of lecture-demonstration tables, the student laboratory

[1] Charles H. Heimler. "A Guide for Science Supervision in the New York State Central School." Doctor's thesis. New York University, New York. 1959.

tables, and gas, water, and electricity utilities in classrooms used for general science.

2. About fifty per cent of the teachers have available for their use science equipment with a total value of more than $1000.

3. The median annual expenditure for science equipment was $250 in the senior high school and $50 in the junior high school.

Science Teaching Problems

One page of the questionnaire contained a list of instructional problems selected from the literature in science education. The teachers were asked to rate each problem as very important, important, or unimportant. Space was also provided for the listing of additional science teaching problems which were encountered by the teachers.

The following list of problems was rated very important or important by a majority of the teachers. The problems are arranged in order of decreasing rating as very important or important. Problem 1 was checked by eighty-nine per cent, and Problem 29 by fifty-nine per cent of the teachers.

1. Provide learning experiences to stimulate the gifted science student.
2. Teaching classes of students who have a great range of abilities.
3. Faulty study habits of students.
4. Teaching the slow learner.
5. Teaching students to think for themselves.
6. Student attitude of doing only enough to "get by."
7. Providing help for individual pupils.
8. Getting all students to actively participate in classroom activities.
9. Student's difficulty in reading science textbooks.
10. Student's difficulty in verbal and written expression.
11. Improving the quality of laboratory experiments.
12. Preparing adequate experiments and demonstrations.
13. Getting students to carry out a science project.
14. Teaching problem solving or scientific method.
15. Heavy teaching load—too many classes or too many preparations.
16. Overcrowded general science classes.
17. Developing classroom discussion that is effective and stimulating to most students.
18. Providing remedial work in reading.
19. Difficulty of teaching pure, basic science without using "gimmicks" to get pupils interested.
20. Providing improved library facilities in science.
21. Lack of adequate demonstration and laboratory facilities for general science.
22. Transfer of classroom learning activities to life activities.
23. Inflexible schedule does not allow time for field trips and extracurricular activities during the school day.
24. Devising tests that accurately evaluate a student's learning and achievement in science.
25. Arranging and conducting field trips.
26. Other school activities, such as announcements or taking children out of science class, interfere with science class teaching.
27. Teaching students to recognize the difference between fact, theory, and superstition.
28. Supplying supplementary science reading material.
29. Difficulty in procuring motion

pictures at the time the teacher desires to use them.

The following problems, although not listed on the questionnaire, were suggested by a majority of the teachers.

1. Teacher's lack of background in science subject matter.

2. A rapid turnover of personnel. A lack of continuity and stability of program and teacher-student relationship.

3. Failure of administrators and curriculum workers to recognize the special needs of science.

4. The science teacher is "spread too thin" by teaching several science courses.

5. Regents examinations and present state syllabi necessitate the coverage of an excessive amount of subject matter in a science course. This results in a skimming over of the course work.

Conclusion

The information gathered in this study indicates that although the science programs in small central schools are standardized by the state syllabi, Regents examinations, and a lack of variation in the textbooks used, there is a considerable difference among schools in regard to the quality of the science program. Specifically, there is a need for the improvement of science teaching, for a reduction in the turnover of science teachers, and for the improvement of physical facilities available for science teaching.

The need for strengthening science programs is of special significance in grades seven, eight, and nine. In many schools, science teaching in these grades consists of the reading, writing, and talking about science and is characterized by a lack of adequate demonstration and student laboratory work.

The study of science teaching problems clearly indicates that the science teachers encounter identifiable instructional problems. Many teachers indicated on the questionnaire a desire for aid and assistance in the analysis and solution of their problems. This information should be of particular value to science supervisors who are interested in providing leadership for the improvement of science instruction.

• • • *Rebuilding the Science Program* • • •

Biology

Experimental Biology II

By WILLIAM C. CARDEN

Head, Science Department, San Miguel High School, Spring Valley, California

This report was an entry in the STAR (Science Teacher Achievement Recognition) program of 1960, conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

THE above title may have two different connotations, however they both apply. Biology II is experimental in that it is a new subject in our district schools [1] (being offered for the second time this year) and it is also experimental in its concept.

The writer developed the subject matter for this course out of a need for more experimentation among biology students. A typical course in Biology I encompasses a vast area of subject matter. At our school it consists of four main units, as follows: Introduction (including Conservation), Plant Kingdom, Animal Kingdom, and the Systems of Man. There are many subheadings under each unit and it takes a full school year to introduce all of the terminology, theory, and basic concepts into such a course. Hence, the lecture-demonstration technique of teaching may tend to over-monopolize such a course. As a result students do not have the desired amount of time to do individual experimentation.

It was noticed particularly that students had considerable trouble in completing the requirements of a project in Biology I; especially a project that showed individual research and initiative. From this evidence the writer developed a curriculum for a course in Experimental Biology II.

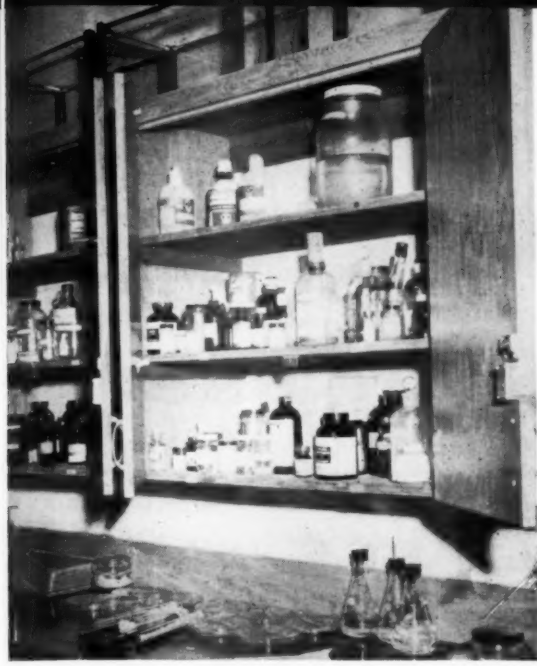
We begin the year by reading a book called *How To Do An Experiment.*[2] This book points out the proper methods of problem solving and the step-by-step procedure which is the nucleus of the scientific or research method of experimentation. Many experiments and project suggestions can be found in this book. The book, through its varied topics, tends to generate good class discussion. There is a special section in the book on the fundamentals of statistics which is useful. After finishing the book the students are given a short unit on the metric system and a test of the material covered thus far.

The students next become familiar with the laboratory facility. They learn the proper names and uses of all the equipment and where the materials are stored. The above step is an important one as it tends to free the teacher from continually explaining what materials to use and where to find them.

To aid the student in selecting topics for possible experimentation, the writer gathered a large collection of articles from such magazines as *The Science Teacher, Chemistry, Scientific American, The American Biology Teacher, Science Newsletter,* and others. These articles are briefly discussed with the thought of carrying on further investi-

[1] Grossmont High School District, Grossmont, California.

[2] Philip Goldstein. *How To Do An Experiment.* Harcourt, Brace and Company, New York. 1958.



Cabinets for storage of chemicals and supplies.

gation. Then each student was presented with thirty-one "open-ended" experiments [3] that might initiate scientific discovery. An excellent sourcebook titled *Laboratory and Field Studies in Biology* [4] is also made available to the students. The writer feels that no biology teacher should miss the opportunity of obtaining this reference source. Many thought-provoking experiments can be found within its pages.

At this point the class members had been well versed in the knowledge of experimentation and were ready to begin work. The whole group started at once by making a soil analysis of the new school lawn. It was noted that there were isolated patches of burned grass at various locations on the lawn. They took soil samples from both the green and brown areas for comparison purposes. They scientifically tested the soil and came to the following conclusions: (1) the burned areas were caused by an overabundance of nitrate fertilizer; it was recommended that potassium be added to the soil to neutralize this condition; (2) the burned areas along the sidewalk were caused by the fertilizer being brushed from the walk to the bordering grass causing an over-concentration; (3) the brown areas near the sprinklers were caused perhaps by the leaching of the minerals into the soil. This soil experiment was cited as an example of a group project.

The next step was to present each member of the class with a text called *A Sourcebook for the Biological Sciences*.[5] This book provides hundreds of experiments that students can perform to learn basic laboratory techniques, increase their over-all knowledge, and to help them get started on long-range projects. Numerous assignments are made from the materials in the text. For example, describe ten experiments that can be performed to prove certain facts about the circulatory system in animals. The continuous assignments from the text tend to keep the student well supplied with project possibilities.

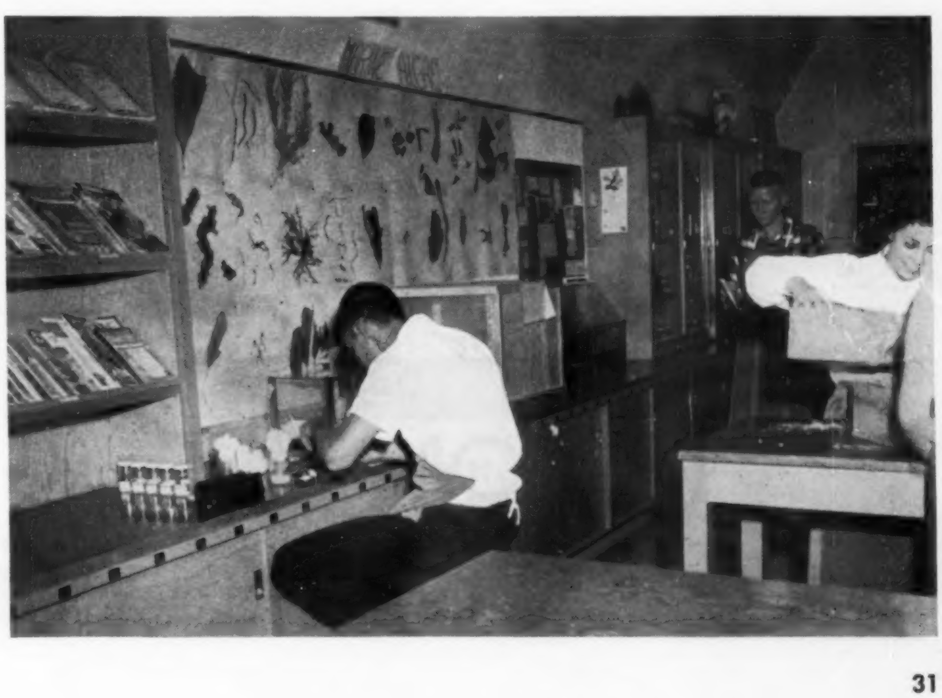
In Biology I students learn many new facts, theory, and basic knowledge. Biology II provides them with the opportunities to prove these facts and check the theories learned through individual experimentation and the application of knowledge previously gained. For example, Biology I students learn that green plants combine carbon dioxide and water in the presence of light to form simple sugars in the process known as photosynthesis. Many green plants convert this sugar to starch in their leaves. This particular experiment and many more may have been included in Biology I, but knowledge gained firsthand by the student will be retained much longer. There is just not enough time in Biology I to allow the students to gain all of this personal experimental experience.

In actuality the students in Biology II can act as resource personnel in that they can provide demonstration materials for the teacher while he is covering a particular unit in first-year biology. Hence, the students recheck numerous facts learned in many subject areas during Biology I. The students become versed and act as authorities on particular areas of the subject matter. This knowledge through experimentation can be demonstrated not only in their own class, but also to other classes in the school, thus giving the students experience in presenting what has been learned.

The experimentation thus far presented might be interpreted as an application of the technical or outline method of problem solving. From this initial step in experimentation, however, the student learns laboratory technique and has broadened his knowledge to the point of doing some original research. Original research could well be labeled as the goal of the course, because it encompasses so many basic fundamentals.

The students are currently carrying on the following investigations: the effect of cigarette smoke on rats, bone-staining techniques, plant and animal

A view along the inside wall of the laboratory. Students are working on varied projects.



[3] Manufacturing Chemists' Association. Compiler. *Scientific Experiments In Chemistry*. Henry Holt and Company, Inc., New York. 1959.

[4] National Academy of Sciences-National Research Council. Compiler. *Laboratory and Field Studies in Biology—A Sourcebook for the Secondary Schools*. Washington, D. C. 1957.

[5] Evelyn Morholt, Paul Brandwein, and Alexander Joseph. *A Sourcebook for the Biological Sciences*. Harcourt, Brace and Company, New York. 1958.

A view at the back of the main room showing numerous small drawers for storing materials. Two students remove aprons for wear during experiments.

reactions to hormones, mold-bacteria relationships, nuclear stains, photomicrography, hydroponics, chromatography, effect of wonder drugs on bacteria, estimating the Vitamin C content in citrus fruits, slide making, frog pituitary experiments, nutrition experiments, the effect of cigarette tars on the skin of animals, and cancer research.

The course is given for two semesters or one school year in length. The last part of the year will be spent in specific subject areas that need greater clarification and presentation over that covered in Biology I. Such topics as classification, evolution, comparative anatomy, comparative embryology and development, field biology, and genetics will be included in the second semester.

Lecture materials are obtained from a number of reference sources including Scheinfeld's book, *The New You and Heredity*,[6] and *The Science of Biology* [7] by Weisz, and, to teach classification, the Jaques [8] book on insects. Actual experience in the classifying of plants and animals is valuable for students continuing in college.

In order to include Biology II in the curriculum it is necessary to have an adequate laboratory facility (See illustrations). Storage space must be provided. Our laboratory consists of numerous cabinets, some with shelves, and others with drawers. At the back of the room we have five cabinets containing one hundred and fifty drawers (19″ x 11″). These drawers are used to store small items of equipment, clippings, and articles covering all phases of biology, project ideas, Turtox Service Leaflets,[9] basic sets of student laboratory equipment, and individual drawers for the Biology II students. The basic set of laboratory equipment consists of one dissecting kit, one apron, and one tripod magnifier. The materials are stored in numbered drawers, one through thirty-five, and are shared with first-year students. The writer has found that this method of storing equipment is very successful. For example, if something is missing from drawer number ten, the student in the next class will notice and report it.

In our storeroom we have a vast area for keeping chemicals, bottles, laboratory apparatus and supplies including glassware and dissecting pans. Large pieces of equipment are also stored there, such as the autoclave, kymograph, incubators, hot plates, tri-simplex projector, and the refrigerator.

In the plant and animal room can be found additional storage space for animal food, cages, aquaria, terraria, and herbaria materials.

The main body of the room has abundant storage. Cabinets extend the length of the room on each side. Numerous electrical outlets, display cabinets, magazine shelves, laboratory work shelves, and large storage cabinets can be found. Every student in the class is provided with a microscope even though the class may be as large as thirty-five.

Since many laboratories are not always well equipped, perhaps industry and local organizations might be asked to help contribute materials. The local hospital, for example, can supply used graduated dextrose bottles including plastic tubing and shut-off valves. They will hold one liter and can be used in many ways including a method of supplying a continuous water supply to animals that will be left unattended during a vacation period. Wood cabinets, drawers, test-tube holders, etc., could be made in the wood shop at school.

In developing this course the writer limited the number of students to twenty. This select group was obtained on the basis of grades made in Biology I. Only those students that had made an *A* or *B* were admitted with a few exceptions involving *C* students. It was found that some *A* students had difficulty with their experimentation, while some of the *C* students were quite successful in the application of knowledge learned. This tends to show the negative results that may occur as a result of strict memorization. After facts are learned, it is important that an opportunity be provided for additional study and experimentation.

[6] Amram Scheinfeld. *The New You and Heredity*. J. B. Lippincott Company, New York. 1950.

[7] Paul B. Weisz. *The Science of Biology*. McGraw-Hill Book Company, Inc., New York. 1959.

[8] H. E. Jaques. *How to Know the Insects*. Second Edition. William C. Brown Company, Dubuque, Iowa. 1947.

[9] The *Turtox Service Leaflets* may be obtained by contacting the General Biological Supply House, 8200 South Hoyne Avenue, Chicago 20, Illinois.

The laboratory workroom is basically an informal one. There is no formal seating arrangement, and as much as possible the atmosphere is maintained similar to what is found in college laboratories. The students work independently and are allowed all the freedom necessary in obtaining material from the cabinets or using equipment without a formal check-out system. This freedom of action is appreciated by the students, and they realize that any violations would result in strict controls that they do not want. It might be added that last year's inventory had no missing items. Under such conditions it is very important that the criterion of maturity be considered in addition to that of scholarship. It only takes one student in an informal situation to completely spoil a laboratory atmosphere.

A bulletin board is provided for scientific articles that will keep the students up to date with recent investigations and at the same time stimulate them to more effort. Each student is obligated to sign his name to the article attesting that he read the information. All students keep a daily log in which they accurately report their activities for the period. The log plus write-ups of their investigations, together with class notes and research reports, are kept in a folder that is periodically checked for accuracy and progress.

The writer endorses this course in Biology II and would like to see it spread to other districts. There is a great challenge present in such a course, both for the student and the teacher. The writer has conversed with professors from various institutions who express the need for such a course in experimental biology before college. Biology II meets a need in our society at a time when our nation must develop scientists well skilled in the scientific method of experimentation.

• • • Rebuilding the Science Program • • •

Semimicro Chemistry

Pilot Chemistry Experiment

By W. L. HUBBARD

Science Chairman, Plant High School, Tampa, Florida

PLANT High School is located on the south side of Tampa in one of the largest and fastest growing areas on the west coast of Florida. Each year's enrollment increases by a sizable percentage over that of the previous year. As the budgets for school equipment and supplies are based on the average daily attendance of the previous year, increased enrollments consistently leave a shortage of funds.

The chemistry department at Plant, with a fifty per cent increase in student registration, tried a dollar-stretching experiment which has proved to be a success. Investing $200 in semimicro chemistry equipment was the steppingstone which led to an over-all county saving of several thousand dollars. With the cooperation of the Hillsborough County Helping Science Teacher and Plant High School's Science Supervisor, the author established a long-range plan encompassing the purchase of equipment and classroom arrangement and procedures.

Several catalogs of semimicro chemistry equipment and supplies were compared so that the most material could be purchased for the money expended. Necessary equipment included semimicro glassware, balances, and a centrifuge, the only expensive piece of equipment; a sufficient supply of chemicals was already on hand.

The largest chemistry class at Plant, numbering thirty-eight, was used as the pilot class. During the first semester of 1959 they took the regular macrochemistry course, and particular attention was given to their grades and records. When the new course began in the second semester, these thirty-eight students switched from macro- to semimicro chemistry. A close study of grades at the end of the school year showed that the semimicro chemistry class achieved a twenty per cent grade improvement over the averages of students in the regular macrochemistry classes.

The Classroom. The classroom is simple in its arrangement. Nineteen tables, 22 inches wide and 60 inches long, are numbered and placed in rows. Two chairs are used at each table. The room is equipped with two sinks, one on the side near the back of the room and the other at the teacher's demonstration desk. Balances and the centrifuge are on the demonstration table.

An oblong cart serves as storage for the trays of chemicals. The cart is 25 inches by 46 inches, five shelves high, and mounted on wheels for ease in mobility. Acid blocks are stored on the top shelf. No electrical or gas outlets are necessary as an alcohol lamp provides all of the heat needed in semimicro chemistry.

Each of the student tables has a tote-tray numbered to correspond with it. The trays are sturdy polyethylene vegetable crispers, 14 by 8 by 4½ inches, purchased from a local drug store at cost. All equipment is kept in these trays—the pneumatic trough, which is an aluminum meat loaf pan, gas bottles, wire gauge, forceps, crucible, test tubes and holders, evaporating dish, rubber stoppers, glass and rubber tubing, spatula, pipe stem triangle, clamp, flask, beakers, stirring rod, litmus and filter paper, splints, and similar articles. As semimicro equipment is so small, the tray is still only about half full. To the author's surprise, students took pride in keeping their glassware clean and care in handling it. At least for the year, the trays and materials belonged to them.

Class Procedure. Students are seated two to a table; the roll is checked; labo-

ratory manuals are distributed, one to each table as the students work in pairs; a laboratory exercise is named; and any special instructions are given. The cart containing the chemical trays and acid blocks is rolled out of the stockroom and moved to one corner of the laboratory. One student picks up a tray and acid block, numbered according to his table, while his partner picks up the tote-tray from the stockroom. With only five minutes of class time consumed, the laboratory is now ready to begin and can proceed uninterrupted for the remaining forty-seven to fifty minutes. At the close of the period, tote-trays are returned to the stockroom shelves and chemical trays to the storage cart. Everything is in place for the next laboratory class. This is a big timesaver for the teacher who no longer has to spend another hour after school preparing for a laboratory class, as is often necessary in macrochemistry.

For the most part, the chemical trays hold about a year's supply of seventy-four chemicals. This is a sufficient amount of all the chemicals needed to do more than one hundred experiments. The acid blocks hold the three main acids and two common hydroxides. Two centrifuges and three sets of balances easily take care of an average class of thirty students.

With the exception of the centrifuge and chemicals, the initial cost for the new laboratory setup averaged about \$12 per student. By replacing rubber and glass tubing, litmus and filter paper, wood splints or a wire gauze, a class could use the same equipment the following year at a cost of from \$1 to \$2 per student. In the pilot class of thirty-eight, only two 10-ml graduate cylinders and three evaporating dishes were broken during the semester.

Advantages of Semimicro Chemistry.

1. The initial cost is less than half that of the macrochemistry course.
2. Breakage is very low.
3. Students seem to take more pride in equipment and its care.
4. A very small amount of chemicals is used as compared with that for macrochemistry.
5. Students learn to weigh, measure, and mix chemicals used, as well as to prepare solutions of different concentrations.
6. Students work at their own speed. When they finish one experiment, they may proceed to the next one. Some students may be several pages ahead of other students in the class. This also staggers the use of the balances and centrifuges which are considered "community" property.
7. Better class organization also improves the behavior in the classroom.
8. The teacher can be an instructor instead of a stockroom dispenser of chemicals.

Alleged Disadvantage. "Tinkering." With the exception of a few isolated examples, little tinkering occurred in the pilot class. A mindful teacher can keep this to a minimum.

Semimicro Versus Macrochemistry. In semimicro chemistry students seem to develop laboratory skills and general comprehension of what they are doing to a larger degree than they did while taking macrochemistry. There was no lowering of standards or loss of laboratory skills. In fact, students liked the orderly and precise methods used in the new course, and this could account for the improvement of grades. The laboratory was cleaner, the equipment was easier to manipulate, results of tests were obtained more quickly, and students accomplished more than in the

Through the use of semimicro balances, students learn to obtain great accuracy in measurements.

Individual equipment tote-trays, acid blocks, and chemical trays are standard materials for each table in the semimicro laboratory.

same length of time in the conventional macrochemistry laboratory.

No special chemicals are needed, only those used in regular macrochemistry, but a smaller quantity is used. For example, an experiment in the macrochemistry laboratory called for fifteen grams of salt; the same experiment in semimicro chemistry called for only one gram. This is true of every element or compound used.

The experience gained in the first semester of the new course indicated that no special teacher training was necessary to change from macrochemistry to semimicro chemistry. Students liked it from the beginning, and their work showed improvement in grades. The cost is less per student. In addition, the teacher can spend most of his time with the students instead of in the stockroom.

The chemistry teachers in Hillsborough County were invited individually to visit the class. In 1960 all of the high schools in the county, except one, used semimicro laboratory methods. Last year the county spent nearly $5000 equipping and supplying a remodeled room into a macrochemistry laboratory. The newest high school in the county opened in September 1959, and spent $1800 for its *initial order in semimicro equipment*. Another new high school, opening in September 1960, will also be equipped for semimicro chemistry. The experiment at Plant High School has proved to be a success.

As a regular feature of The Science Teacher, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to TST's calendar editor as early as possible.

September 9-10, 1960: NSTA Regional Conference, University of North Carolina, Chapel Hill, North Carolina

September 12-15, 1960: 138th National Meeting, American Chemical Society, Biltmore Hotel, New York City.

September 29-October 1, 1960: NSTA Regional Conference, University of North Dakota, Grand Forks, North Dakota

October 28-30, 1960: NSTA Regional Conference, Deauville Hotel, Miami Beach, Florida

November 4-5, 1960: NSTA Regional Conference, Arizona State University, Tempe, Arizona

November 6-12, 1960: American Education Week. Theme: Strengthen Schools for the 60's

November 24-26, 1960: 60th Convention, Central Association of Science and Mathematics Teachers, Statler-Hilton Hotel, Detroit, Michigan

December 26-30, 1960: NSTA Annual Winter Meeting in conjunction with 127th meeting of the American Association for the Advancement of Science, the Commodore and Biltmore Hotels, New York City

February 1-4, 1961: Annual Meeting, American Association of Physics Teachers, Hotel New Yorker, New York City

February 22-25, 1961: 34th Annual Meeting, National Association for Research in Science Teaching, Pick-Congress Hotel, Chicago, Illinois

March 25-29, 1961: NSTA Ninth Annual National Convention, Hotel Sherman, Chicago, Illinois

Classroom IDEAS

General Science

Scientific Toys as Teaching Aids

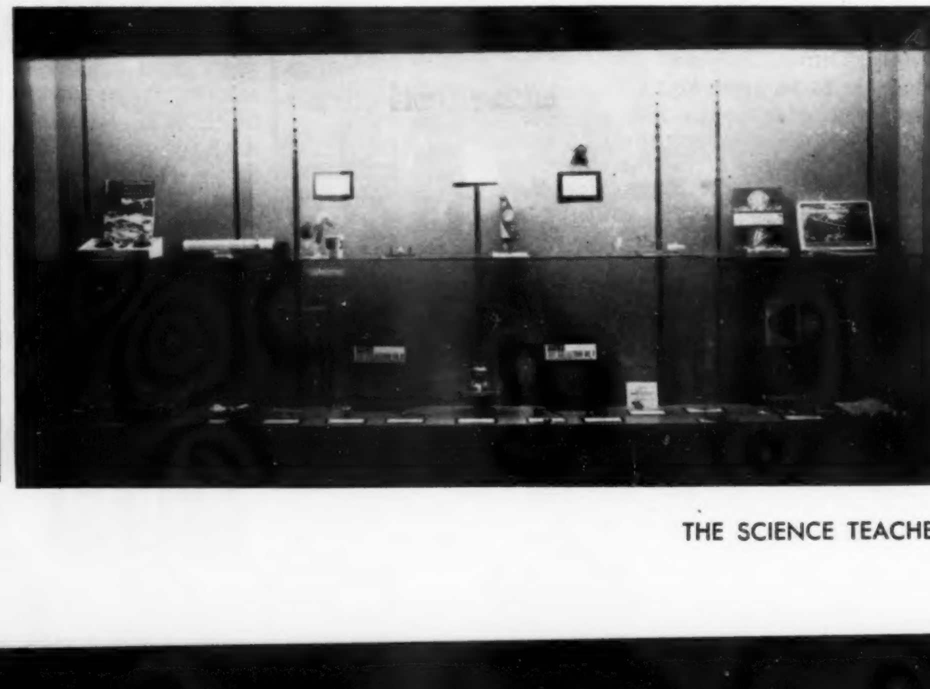
By ROBERT L. GANTERT, Alexander Hamilton Junior High School, Seattle, Washington

During the past year, Alexander Hamilton Junior High School conducted an experimental program using a selected series of scientific toys to illustrate the basic principles of physical science. On the theory that "you must show it to sell it," about fifty toys were displayed in the school's main showcase for two weeks. (See photograph.) Accompanying each toy was a typed card giving the pupils a brief clue to the scientific principle involved. A question-and-answer box was also placed alongside the showcase and pupils were invited to drop their replies and queries in the slot. By the end of the second week of the exhibit the quiz box was jammed to overflowing.

On the basis of these questions and answers, the toys which had elicited the greatest scientific interest were selected for use in all of the science classes at Hamilton. Each teacher submitted a report on their effectiveness as classroom teaching aids. Complicated science kits which required additional research and study were turned over to the more capable students in the ninth grade. These high aptitude students were allowed a week to organize and experiment with the kits at home. When the teacher was satisfied that the chosen pupil thoroughly understood the units in the kit booklet, he was assigned a one-hour class period to demonstrate the contents of each kit. One fourteen-year-old ninth-grade boy whose father was an electronics engineer gave such an erudite demonstration with his assigned kit that he was asked to repeat his performance at an afternoon meeting of the PTA. The first shipment of scientific toys required about four weeks of teaching time and fitted easily into the required science curriculum.

In the second experience with the toy teaching aids, presentation was made to a special science class taught at Hamilton one evening a week during

Each toy displayed in the main showcase of the school provides a clue to some scientific principle.



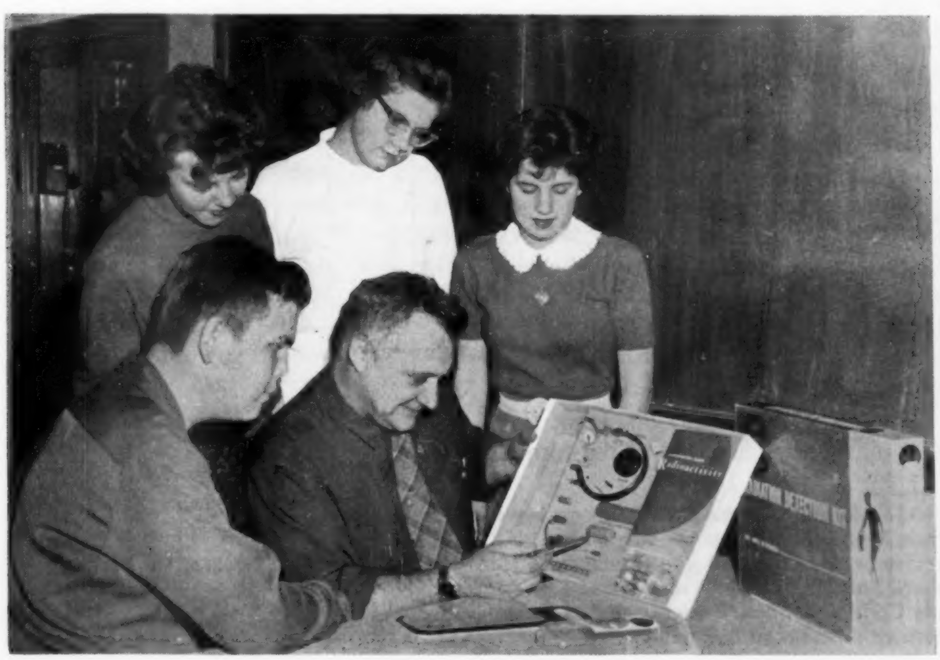
What is the scientific principle that the "Drinking Duck" demonstrates?

the second semester. Fourteen boys, ages ten to eleven, were enrolled in this class. All of their fathers were professional men—doctors and lawyers in the community—who had decided to sponsor a science club which would stimulate interest in science and satisfy the enthusiasm of their offspring. Here, again, the toys helped immeasurably to bring understanding to an age group as yet unqualified to grasp technical details.

The third presentation was the most rewarding experience and involved the use of the scientific toys in the Seattle Public Schools' 1959 Elementary Science Enrichment Program. In this special course geared only to high aptitude pupils in the fourth, fifth, and sixth grades, two weeks were devoted to the demonstration and use of the toys in the classroom. It was fortunate that this was the last time that pupils participated with the toys for by now many of the fragile items were damaged beyond repair in the ensuing onslaught of enthusiasm which followed each presentation. The loss, however, was a small price to pay for the knowledge gained by these pupils.

Perhaps the important single value resulting from the use of these teaching aids was the interest which their demonstration created and fostered. For example, it was amazing to find how many people—juvenile and adult alike—really did not understand the principle of one of the oldest of the scientific toys, the "Drinking Duck." Moreover, a readily observed interest was developed in Newton's Laws of Motion by many of the other simple toys. Such interest is a self-perpetuating one for students delighted in explaining the newly found principles to their parents. As a result, a number of parents visited the class both to hear and see their children explain and demonstrate. Through the letters which the Summer School Administration received at the conclusion of the Seattle Science Enrichment Program, the toys as used

Author, seated with student M. McKeown, explains radioactivity through use of science kit to students Barbara Gustafson, Carla Quistorff, and Janet Khile (l. to r.).



were credited as major incentives in creating interest and understanding in science.

More of these scientific teaching aids will be used during the coming school session. As before, the procedure will be:

1. Display and catalog each item in school showcase for limited time.
2. Use the "quiz box" for pupil questions and answers.
3. Assign capable pupil demonstrators to teach the class.
4. Share the knowledge and experience gained with other teachers.

If any teacher would like additional information on the procedure used in this school program, the author will be happy to share the details.

Chemistry

Compounds Without Bonds

By SISTER MARY MARTINETTE, B.V.M., Mundelein College, Chicago, Illinois

The high school student completes his first chemistry course cognizant of the chemical compounds which result from the common known groups of bonding, but he is rarely introduced to a group of compounds which are formed without bonding. An ever-increasing number of literature references to large inclusion-type molecules points to an increased activity in the investigations of a group of versatile compounds known as Molecular Compounds. So many of these interesting macromolecules have now been identified it would seem advisable, when possible, to distinguish between them.

One is the group which has been designated as clathrates. The name "clathrate" was proposed for this group in 1950 by Professor H. M. Powell of Oxford since the compounds have a cage-like structure. It is derived from the Latin word *clathratus* meaning enclosed or protected by crossbars of a grating.

The alert high school student will find that the explanation of the forma-

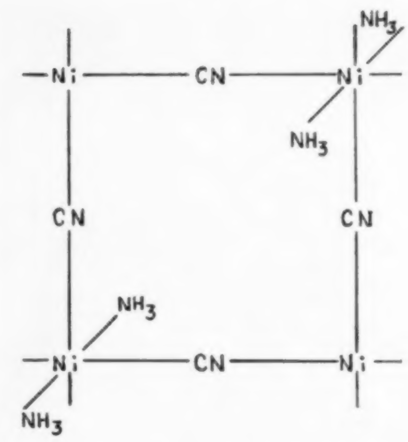
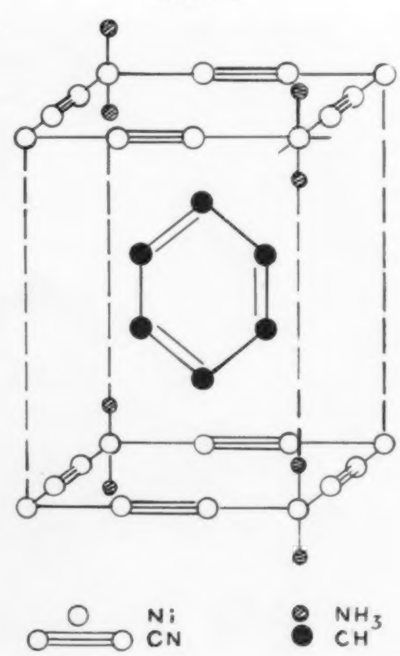


FIGURE 1.

tion of clathrates is both unusual and logical. He will readily understand that these compounds must have always existed and that the explanation of their formation may well be the beginning to an understanding of many unexplained chemical phenomena. He may even become sufficiently motivated to work out a project on the preparation and identification of some of the more simple clathrate compounds.

A clathrate compound has been defined as a solid phase formed by the inclusion of molecules of one species in "cages" which have been formed by molecules of a second species. Quinol was one of the first of such molecules to be studied in detail. By means of X-ray analysis it was learned that the quinol molecule formed a complex cage-like structure with itself, by means

FIGURE 2.



NOTE: In 1959-60, the author was on leave from Mundelein College as visiting chemistry professor, Marillac College, Normandy, Missouri. She spent the past summer at University College, London, England, on a National Science Foundation fellowship.

of hydrogen bonding. Though the quinol molecules were bonded together, they formed a framework in which there existed cavities large enough to contain small molecules, trapped, not bonded. One cavity formed as the result of the hydrogen bonding between each three quinol molecules. Stoichiometric relationships between the "cage" and its "captive" were shown to exist, giving clathrate molecules of the general formula $3C_6H_4(OH)_2 \cdot M$. The conditions for the formation of such molecules would appear to be: (1) the favorable size of the molecule to be trapped, M, and (2) its stability toward the cage-forming molecules. Compounds such as SO_2, H_2S, and HCOOH, to name just a few, and such atoms as those of Kr and A are known to meet the requirements of quinol clathrates.

There are examples of inorganic as well as organic clathrate cages. Benzene can be readily trapped within an ammonia-nickel-cyanide complex framework. In this compound, $Ni(CN)_2NH_3$, the nickel atoms are linked by cyanide groups in an extended two-dimensional structure with the ammonia groups projected above and below the flat network. The ammonia groups sterically prevent the formation of close layers, and relatively large "holes" exist in the complex structure. If the complex is allowed to crystallize from benzene it will trap the benzene molecules. These molecules happen to have the right dimensions to fit into the holes of the ammonia-nickel-cyanide framework. The compound which crystallizes from benzene is not the complex molecule $Ni(CN)_2NH_3$, but a clathrate compound, $Ni(CN)_2NH_3 \cdot C_6H_6$. The structure of this molecular compound has been investigated (Figures 1 and 2).

The preparation of clathrate compounds is, in some studies, relatively simple. For example, if a quinol solution is saturated with SO_2 gas the clathrate having the formula, $3C_6H_4(OH)_2 \cdot SO_2$, will form as a crystalline solid. These crystals are normally stable. Even the odor of SO_2 is not detectable. Their decomposition may be brought about by heating them to within a few degrees of their melting point, by dissolving them in water, or by grinding them in a mortar.

Within the next decade many more clathrate compounds probably will be prepared and/or identified, and their

usefulness will be greatly extended. Together with the highly interesting and comparable open-structure compounds, such as the urea chains in which molecules may be caught in canals, these clathrates are on their way toward making a name for themselves both in the world of theory and the world of commerce.

Chemistry

Sodium Peroxide Experiment
(Small Scale Preparation of Oxygen)

By PUTHIYAVEETIL ABDU MOHAMED, The New College, Madras-14, India

A fresh sample of sodium peroxide is found to react at room temperature (30°C) with the water of crystallization of many inorganic salts with evolution of heat. A few salts require initial warming, and the oxygen gas evolved readily rekindles a glowing splinter.

The following inorganic salts in a dry state were successfully tested with Na_2O_2. In some cases the oxygen evolved was collected over water in 6-inch by 1-inch test tubes and absorbed over an alkaline pyrogallol solution almost completely.

Alums; $Al_2(SO_4)_3 \cdot 18H_2O$; $Fe_2(SO_4)_3 \cdot 18H_2O$; $Na_2SO_4 \cdot 10H_2O$; $Na_2CO_3 \cdot 10H_2O$; $MgSO_4 \cdot 7H_2O$; $CoSO_4 \cdot 7H_2O$; $NiSO_4 \cdot 7H_2O$; $ZnSO_4 \cdot 7H_2O$; $FeSO_4 \cdot 7H_2O$; $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$; $MnSO_4 \cdot 4H_2O$; $BaCl_2 \cdot 2H_2O$; $Na_2B_4O_7 \cdot 10H_2O$; $Na_3AsO_4 \cdot 12H_2O$; $Na_2HPO_4 \cdot 12H_2O$; $CuSO_4 \cdot 5H_2O$; $Ba(OH)_2 \cdot 8H_2O$.

Deliquescent salts should not be included in the experiment. Anhydrous salts like K_2SO_4, KNO_3, etc., fail to give the test, indicating the absence of water of hydration.

In one experiment, 2.5 g of dry $MgSO_4 \cdot 7H_2O$ was intimately ground with 0.5 g of dry $CoSO_4 \cdot 7H_2O$. This mixture and 5 g of Na_2O_2 from a freshly opened tin can were introduced in alternate layers into a dry 100-cc round-bottom flask fitted with a delivery tube. On shaking the mixture, it was found oxygen evolved steadily. Warming toward the end of the reaction produced more of the gas. About 700 cc of the gas were thus collected over water after the air initially present in the flask was displaced.

Both O_2 and NH_3 are evolved from hydrated ammonium salts; the gases should then be collected over dilute sulfuric acid to remove the ammonia. Even in the case of ferrous salts which can, as reducing agents, consume some of the oxygen, considerable volumes of the gas were collected. Old samples of Na_2O_2, if used, must be tested with water, if O_2 is evolved copiously.

Convention NOTES

Members and friends of NSTA are looking forward to the ninth annual national convention, to be held at the Hotel Sherman in Chicago, Illinois from Friday, March 24, through Wednesday, March 29, 1961. The NSTA Section for Science Supervisors will hold its annual national conference on Friday the 24th, and the Association for the Education of Teachers in Science, also a Section of NSTA, will hold its annual meeting on Wednesday the 29th. The main convention of NSTA will be scheduled between the 25th and 28th.

The convention theme—"The Science Teacher: Seeking Excellence in an Age of Science"—is most appropriate for these times when improvement in science education is being encouraged as never before, when NSTA itself is gathering strength and exerting more leadership through growth and evolution. The 1961 convention is dedicated to recognition of the science teacher's key role in this Age of Science.

Six general sessions will develop the theme in a way that neatly combines its informational and inspirational aspects. The first session, to convene on Saturday morning, March 25, will feature two speakers discussing some of the recent fundamental discoveries in the physical and biological sciences, respectively. These will be designed to give the latest information on advances at the frontiers of scientific research and to evaluate their importance to science teachers. A second general session Saturday evening will bring a similar report on recent advances achieved through international teamwork, specifically through the IGY program. These two informational sessions are intended to narrow somewhat the gap that always exists between what is known at the front lines of scientific discovery and the subject matter taught in the classroom.

In the third general session, which will be held Sunday evening, March 26, an outstanding scientist will speak on the nature of the scientific enterprise, discussing the methods and aims of science and the philosophical and ethical problems inherent in our technological age. The fourth general session, Monday morning, March 27, will provide a leading educator's reactions to the ideas presented by the four scientists as he attempts to define the nature of the educational enterprise in an age of science and technology.

The fifth general session, the annual banquet on Monday evening, will pinpoint the foregoing discussions in terms of the convention theme. The speaker will be Dr. Glenn Seaborg, scientist-educator, Nobel Laureate for his work on transuranium elements, and chancellor of the University of California at Berkeley. He will speak on "The Science Teacher as an Agent in the Educational Enterprise." The sixth and final session, Tuesday, March 28, will feature an inspirational address on the responsibilities of science teachers in our democratic enterprise.

The speakers to make these key presentations have been selected by NSTA President Robert A. Rice, Head of the Science Department, Berkeley, California and Mr. Robert H. Carleton, Executive Secretary for NSTA.

A special presentation will be made on Sunday afternoon by "NCCOPSIS" (Northern California Committee on Problem Solving in Science), a spontaneous, unsponsored, yet highly motivated group of science teachers in the vicinity of San Francisco

GENERAL PROGRAM COMMITTEE, NSTA NINTH ANNUAL CONVENTION

RIALTO PHOTOGRAPHERS

(Front row) Mr. Edward C. Schwachtgen, Chicago Public Schools, Chicago, Illinois; Mrs. Lois E. Dunn, Jefferson County Schools, Lakewood, Colorado; Miss Marilyn Suthard, NSTA, Washington, D. C., Secretary to the Committee; Sr. M. Gabrielle, Holy Trinity High School, Hartford, Connecticut; Miss Katharene Walker, Rogers High School, Florence, Alabama; Dr. Joe Zafforoni, University of Nebraska, Lincoln, Nebraska. (Back row) Dr. William M. Pierce, Ohio University, Athens, Ohio; Dr. Donald W. Stotler, Portland Public Schools, Portland, Oregon; Mr. Robert A. Rice, Berkeley High School, Berkeley, California, President, NSTA; Dr. Oreon Keeslar, Chairman of the Committee, Santa Clara County Schools, San Jose, California; Mr. Robert H. Carleton, Executive Secretary, NSTA, Washington, D. C.; Mr. Frank L. Balmer, York Mills Collegiate Institute, Willowdale, Ontario, Canada.

Bay, which has been working for the past four or five years on the development of high school students' native capabilities for creativity in science and skill in problem solving.

The General Program Committee, under the chairmanship of Dr. Oreon Keeslar, Coordinator of Secondary Curriculum, Santa Clara County Schools, San Jose, California, includes: Mr. Frank L. Balmer, Head of Science Department, York Mills Collegiate Institute, Willowdale, Ontario, Canada; Dr. John B. Chase, Jr., Associate Professor of Education, University of North Carolina, Chapel Hill, North Carolina; Mrs. Lois E. Dunn, Science Supervisor K-9, Jefferson County Schools, Lakewood, Colorado; Sister M. Gabrielle, Principal of Holy Trinity High School, Hartford, Connecticut; Dr. William M. Pierce, Associate Professor of Physics, Ohio University, Athens, Ohio; Dr. Donald W. Stotler, Supervisor of Science, Portland Public Schools, Portland, Oregon; Miss Katharene Walker, Teacher of Biology, Rogers High School, Florence, Alabama; and Dr. Joe Zafforoni, Assistant Professor of Education, University of Nebraska, Lincoln, Nebraska.

In keeping with the convention theme, a wide diversity of panels, individual and group presentations, and demonstrations are being planned by Balmer, Chase, Pierce, Stotler, and Zafforoni, covering all grade levels and interests among NSTA members. Sister Gabrielle has scheduled nearly eighty "Here's How I Do It" presentations at two points in the program, Saturday afternoon and Sunday forenoon. Mrs. Dunn will be in charge of an extensive display of curriculum materials gathered from all over the nation and many foreign lands; in addition, consultant services will be available in conjunction with this display. Miss Walker is making plans for five meal functions and other social activities.

Another key member of the General Program Committee is Mr. Edward C. Schwachtgen, Consultant in Science in the Chicago Public Schools, who is serving as Coordinator of Local Committees. Among those assisting him are Mrs. Mary Mark Sturm, Director of the Division of Home Economics, and Mr. James P. Fitzwater, Director of Visual Education, Chicago Public Schools.

As usual, a feature of the convention will be the annual Exposition of Science Teaching Materials. The record display of 103 booths at the Kansas City convention should be eclipsed by our 1961 convention. Apparatus, equipment, books, audio-visual materials, business-sponsored materials, and other teaching aids for all grade levels will be on display. Time to visit the exhibits will be provided in the daily schedules.

The Hotel Sherman's facilities are fortunately adequate to enable us to hold the entire convention under one roof—a great boon to everyone with sedentary propensities. NSTA members are urged to place their reservations early at the Sherman or one of the nearby hotels. Instructions for advance registration will be mailed from headquarters to all members well in advance of the convention.

NSTA Activities

Board of Directors, 1960-1961

Thirteen elected representatives of the NSTA membership at large comprise the policy-making body of the Association. Serving as officers and executive committee for 1960-61 are: *President*, Robert A. Rice, Berkeley High School, Berkeley, California; *President-elect*, J. Darrell Barnard, New York University, New York City; *Retiring President*, Donald G. Decker, Colorado State College, Greeley; *Treasurer*, J. Donald Henderson, University of North Dakota, Grand Forks; *Secretary*, Mildred T. Ballou, Ball State Teachers College, Muncie, Indiana.

Rounding out the full Board of Directors are the regional directors as follows: Region I, Frederick R. Avis, St. Mark's School, Southborough, Massachusetts; Region II, Hugh Allen, Jr., Montclair State College, Upper Montclair, New Jersey; Region III, Ruth E. Cornell, Wilmington, Delaware Public Schools; Region IV, Robert D. Binger, State Department of Education, Tallahassee, Florida; Region V, Albert Piltz, U. S. Office of Education, Washington, D. C. (on leave from Detroit public school system); Region VI, Milton O. Pella, University of Wisconsin, Madison; Region VII, Horace H. Bliss, University of Oklahoma, Norman; Region VIII, Donald W. Stotler, Portland, Oregon Public Schools.

Elections Committee

It seems that new officers and directors are hardly installed on the NSTA Board of Directors before another election is under way. This is necessary in order to carry out the democratic procedures by which these servants of the members and the profession are chosen.

Step number one, and this is it, is an invitation to *you* to suggest qualified, zealous persons for the various offices for consideration by the elections committee.

Vacancies to be filled in the 1961 balloting are president-elect, chairman of the finance committee (replacing the office of treasurer), and directors for Regions I, III, V, and VII.

In suggesting potential nominees, write directly to the chairman of the elections committee and give brief but clear information as follows: name; title or position; institution; address; office or vacancy for which suggested; experience, activities, accomplishments, and other evidence of leadership interests and abilities.

Chairman of this year's elections committee is John P. Harville, San Jose State College, California. Richard Smith, San Jose State College, is serving as alternate chairman. Others serving on the committee are: Bernice Bryan, Los Angeles, California Public Schools; H. M. Louderback, Lewis and Clark High School, Spokane, Washington; Clyde Parrish, Cubberly High School, Palo Alto, California; Stanley Williamson, Oregon State College, Corvallis.

Business-Industry Section

New officers at the helm of NSTA's pioneer Section, the B-I Section, as elected last March in Kansas City include: *Chairman*, Albert L. Ayers, Hill and Knowlton, New York City; *Vice-Chairman*, Allison McNay, Standard Oil Company of California, San Francisco; *Treasurer*, John P. McGill, American Trucking Association, Washington, D. C.; *Secretary*, Catherine R. Ready, Bristol-Myers Company, New York City.

This Section now enrolls 315 members representing over 250 different business organizations. All are members of NSTA as well as of the Section. Newest among B-I Section local chapters is the San Francisco Bay Area B-I-E Council. Organized last April, three meetings have been held to define purposes, elect officers, and launch a program. Al McNay of Standard Oil Company of California was elected chairman. To head the program committee, the Council selected G. B. Schuyler of Models of Industry, Inc. Also serving on the executive committee are Robert Kelley of Modern Talking Picture Service and Mary Sprague, Pacific Telephone and Telegraph Company. Speakers and discussion leaders in programs to date have included William B. Sanborn, Director of Instructional Materials of the San Francisco Unified School District, and Joseph Bertotti, Manager of Educational Relations for the General Electric Company.

Supervisors' Section

With a brand-new constitution and newly elected officers, NSTA's Section for supervisors, consultants, and coordinators of science teaching is off to a running start. Warm-up meetings of this group have been held in conjunction with NSTA conventions. Continuance of these annual meetings, monograph publications, and a Section newsletter are planned among future activities. An NSTA membership and Section dues of $4 have been set as requirements. Inquiries regarding membership should be sent to the Section secretary; dues should be sent directly to NSTA. Officers elected for 1960-61 are: *Chairman*, Samuel Schenberg, Director of Science, New York City Public Schools; *Vice-chairman*, Elmer W. McDaid, Director of Exact Science, Detroit, Michigan Public Schools; *Secretary*, Kenneth E. Vordenberg, Supervisor of Science, Cincinnati, Ohio Public Schools. Members at large are: Keith F. Smith, Supervisor of Science and Mathematics, Los Angeles, California Public Schools; Grace C. Maddux, Supervisor of Science, Cleveland, Ohio Public Schools; Ralph E. Keirstead, Consultant in Science Education, State Department of Education, Hartford, Connecticut; Elra M. Palmer, Supervisor of Science, Baltimore, Maryland City Public Schools; and George E. Mathes, Director of Science, Denver, Colorado Public Schools.

AETS Section

The third Section of NSTA has been authorized and will be conducted by the Association for the Education of Teachers in Science (AETS). Established some 30 years ago, AETS in its new status is moving to strengthen its national program and form regional units for more effective, grass-roots action in the implementation of policies and goals. Current officers of AETS are: *President*, Harold E. Tannenbaum, State University College of Education, New Paltz, New York; *President-elect*, Herbert Schwartz, New York University, New York City; *Vice-president*, Fletcher G. Watson, Harvard University, Cambridge, Massachusetts; *Past-President*, George Zimmer, State University College of Education, Fredonia, New York; and *Secretary-*

Treasurer, Willard J. Jacobson, Teachers College, Columbia University, New York City.

Membership dues in AETS have been set at $4 with some type of NSTA membership required. Send all membership payments directly to NSTA headquarters. Inquiries about membership eligibility, services, and activities should be sent to the AETS secretary. Now available from AETS is a 48-page publication, *Current Concerns and Issues in Science Education,* priced at $1. This is a collection of five addresses and reports of panel discussions presented at the Kansas City meetings last March.

OCDM Project

What guidelines and criteria should be established to integrate science concepts into civil defense education in our schools? This is the problem that an NSTA committee wrestled with at a three-day meeting in Washington, D. C. last June. The committee membership included James Wailes, University of Colorado, Boulder, *Chairman;* Nellie McCool, Highland View Junior High School, Corvallis, Oregon; Harry K. Wong, Menlo-Atherton High School, Atherton, California; Ellsworth S. Obourn, U. S. Office of Education, Washington, D. C.; and John W. Renner, NSTA.

Working with the committee also are Walker Agnew, director of the Civil Defense Education section of the U. S. Office of Education, and Harold Mehrens, director of the program for the preparation of civil defense education materials for school use.

The criteria established by this committee have been forwarded to the University of California where the teaching materials for civil defense education are being prepared. A companion study in the integration of social studies concepts in civil defense is also being conducted in cooperation with the National Council for the Social Studies, NEA. When published, the materials will be made available to the NSTA membership.

Elementary Science Study

What are the elements of the emerging elementary science programs throughout the country? This question is now under study by NSTA. A thorough survey of science programs will be made by Joe Zafforoni, University of Nebraska, Lincoln, working in cooperation with an advisory committee including Mildred T. Ballou, Ball State Teachers College, Muncie, Indiana (Secretary of NSTA); Paul Blackwood, U. S. Office of Education, Washington, D. C.; Margaret McKibben, NSTA; and Orville Aftreth, Motley School, Minneapolis, Minnesota, representing the NEA Department of Elementary School Principals. The group met in Washington with Dr. Zafforoni to establish policies and to design the procedures necessary to conduct the study.

When the results of this research are added to the study of *New Developments in High School Science Teaching,* already in print, NSTA will have a comprehensive picture of "new developments," kindergarten through the twelfth grade. Both of the studies have been supported by grants from the Shell Companies Foundation, Inc.

Regional Meeting, Miami Beach

"Facing the Challenge in Science Teaching" is the theme of a regional meeting to be held at the Deauville Hotel, Miami Beach, Florida, October 27-29. As it is now planned, the program includes: Reports from Cape Canaveral; Symposium on Significant Developments in Science Education; Symposium on Building a K-12 Program in Science; "Here's How I Do It" Sessions for Elementary, Junior High, and Senior High Levels; Discussion Groups on a wide variety of topics for all levels; Tours in Miami Area.

Registration will commence at 7:00 p.m. Thursday evening and be followed

with a coffee social. Later, an executive meeting of the Florida Association of Science Teachers will be held.

Friday, October 28

8:00 a.m. Registration; exhibits.

9:00 a.m. General Session. Robert D. Binger, Presiding. Supervisor of State Department of Education, Tallahassee, Florida

(a) Welcome: Joseph Hall, Dade County Public Schools, Miami

(b) Greetings: Delivered by R. D. Binger for Thomas D. Bailey, State Department of Public Instruction, Tallahassee

(c) Greetings: Henry Graziano, Florida Association of Science Teachers

(d) Greetings from NSTA: Robert A. Rice, President, NSTA

(e) Keynote Address: Joseph Schwab, University of Chicago. "Nature of Sciences and Its Implications for Education"

10:15-11:00 a.m. Exhibits, science teaching films (elementary, biological, physical)

11:00-12:15 p.m. General Session. Lewis DeLaura, Presiding. Principal, Southwest Junior High School, Melbourne, Florida

Address: Lt. Col S. F. Spear, Director of Information, USAF, Patrick Air

Force Base. "Cape Canaveral Reports"

12:30 p.m. Informal luncheon. H. V. Bullock, Coordinator, Science Education, State Department of Education, Atlanta, Georgia

Address: Sidney J. French, Dean, College of Basic Studies, University of South Florida, Tampa. "Science in War and Peace"

2:00-3:00 p.m. "Here's How I Do It" Sessions

I. Elementary—N. Eldred Bingham, Presiding (Florida)

II. Junior High School—Richard W. Copeland, Jr., Presiding (Florida)

III. Biological—Ernest Burkman, Presiding (Florida)

IV. Physical Sciences—Frances Jones, Presiding (Alabama)

3:30 p.m. Exhibits, science teaching films (elementary, biological, physical)

Dinner hour. "Free"

8:00 p.m. Concurrent Symposia: "Significant Developments in Science Education"

Symposium A. Frank Brown, Presiding (Florida)

8:00-9:00 p. m. Elementary Science

9:00-10:00 p.m. Biological Sciences Curriculum Study (BSCS)

Symposium B. Erline Curlee, Presiding (Alabama)

8:00-9:00 p.m. "Chemical Bond Approach" (CBA); "Chemical Education Materials Study" (CHEM)

9:00-10.00 p.m. Earth Science

Symposium C. Harriet Ehrhard, Presiding (Florida)

8:00-9:00 p.m. Junior High Science

9:00-10:00 p.m. Physical Science Study Committee (PSSC)

Saturday, October 29

8:00 a.m. Exhibits; films; registration.

9:00 a.m. General Session. NSTA—Robert A. Rice, Presiding

Symposium: "Building a K-12 Program in Science"

(a) 20 min. N. Eldred Bingham—Elementary (Florida)

(b) 20 min. Helen E. Hale—Junior High School (Maryland)

(c) 20 min. Annie Sue Brown—Biological Sciences (Georgia)

(d) 20 min. Almond Fairfield—Physical Sciences (Florida)

Report: William P. Ladson, NSTA. "Future Scientists of America Program"

11:00 a.m. Special Interest Groups

(1) Traveling Science Teacher Program for State and Local Groups

(2) Georgia's New Science Program 1-12

(3) The Emerging Pattern of Elementary Science

(4) Science on TV—Elementary and Secondary

(5) The Role of the Science Research Course and Science Seminars

(6) Teaching for Critical Thinking in Elementary Science

(7) Ecology of the Everglades

(8) Research Experience for High Ability Secondary School Students

(9) Team Teaching in Science

(10) School Gardening

(11) The Central Florida Museum and Planetarium

(12) Outdoor Science Education

12:30 p.m. Informal luncheon. J. Stanley Marshall, Presiding. Professor of Science Education, The Florida State University, Tallahassee

Address: Philip Wylie, Author, Miami, Florida. "Science: Limitless or Limited?"

2:00 p.m. Tours

(A) Fairchild Tropical—$3

(B) Everglades National Park—$3

(C) Seaquarium—$4

Note: *Please consult final program copy before the meeting since some of these items may need to be revised.*

FSA Activities

FSAA, 1961

For the tenth consecutive year, NSTA is conducting a student science awards program dealing with projects prepared by young people in grades seven through twelve. Formerly known as the Science Achievement Awards for Students, this program will henceforth be called Future Scientists of America Awards (FSAA). To expedite fairness of competition and equality among states, a system of eleven geographical regions has been established within the United States. Similarly, there are three category divisions according to grade level: grades 7-8, 9-10, and 11-12. In this manner, a seventh-grade student will not be compelled to compete with a twelfth-grade student. Revision of the program includes some internal changes. For example, the national competition among projects limited to metals and metallurgy has been eliminated.

The materials for the 1961 FSAA are currently available and may be obtained by writing to the Future Scientists of America, NSTA, 1201 Sixteenth Street, N. W., Washington 6, D. C. Teachers are urged to request materials for not more than ten per cent of their students. If more material is desired, please give a full explanation of the needs.

Science World Committee

Arrangements between NSTA and Scholastic Magazines, Inc., for the merger of *Tomorrow's Scientists* with *Science World* will be continued in 1960-61. During the past year, NSTA has been represented on the *Science World* editorial board by the following committee: Sam S. Blanc, Gove Junior High School, Denver, Colorado; Anne E. Nesbit, South Junior High School, Pittsfield, Massachusetts; and Stanley E. Williamson, Oregon State College, Corvallis, Oregon. Teachers and students who read and use *Science World* are invited to send suggestions to this committee.

Research Participation

Efforts of NSTA to test the educational effectiveness of grants to teachers for on-the-job research have reached the point at which an attempt should be made to study, assess, and evaluate the program. On the 1960-61 FSA agenda, this study would include all grants made by NSTA-FSAF as well as those given to teachers by the National Institutes of Health, the American Heart Association, and others which may be identified. Completion of the report will be the termination point of the program.

FSA Publications

Several best-selling student publications are still available from NSTA. Three in which you may be specially interested are: *Encouraging Future Scientists: Student Projects* (50 cents per copy); *If You Want to Do a Science Project* (50 cents per copy); and *Encouraging Future Scientists: Keys to Careers* (single copies free; additional copies 10 cents each).

A project of the U. S. Office of Education may be of interest to teachers. A contract has been let for the compiling of an annotated bibliography of information and materials relating to careers in engineering, mathematics, and science. This will be done under the direction of A. Neal Shedd, Specialist in Science of USOE. The publication will be available by January 1, 1961, and may be obtained by writing to the U. S. Office of Education, Washington 25, D. C.

Youth Conference on the Atom

The second annual Youth Conference on the Atom will take place in Chicago, October 20-22, 1960, at the Museum of Science and Industry. Student scientists from 38 states will convene to study the atom as it is used in a myriad of peaceful applications and as a frontier of science. The students taking part will be chosen from among the nation's brightest youths through science fairs, aptitude examinations, and by leading educators.

Sponsored by 62 electric light and power companies and co-sponsored by the National Science Teachers Association and the Future Scientists of America Foundation, approximately 250 students, accompanied by their science teachers, will participate in the three-day conference. Students and teachers will be addressed by some of America's foremost scientists and will take part in group discussion sessions with scientists from the Argonne National Laboratory, the University of Chicago, and/or the Illinois Institute of Technology.

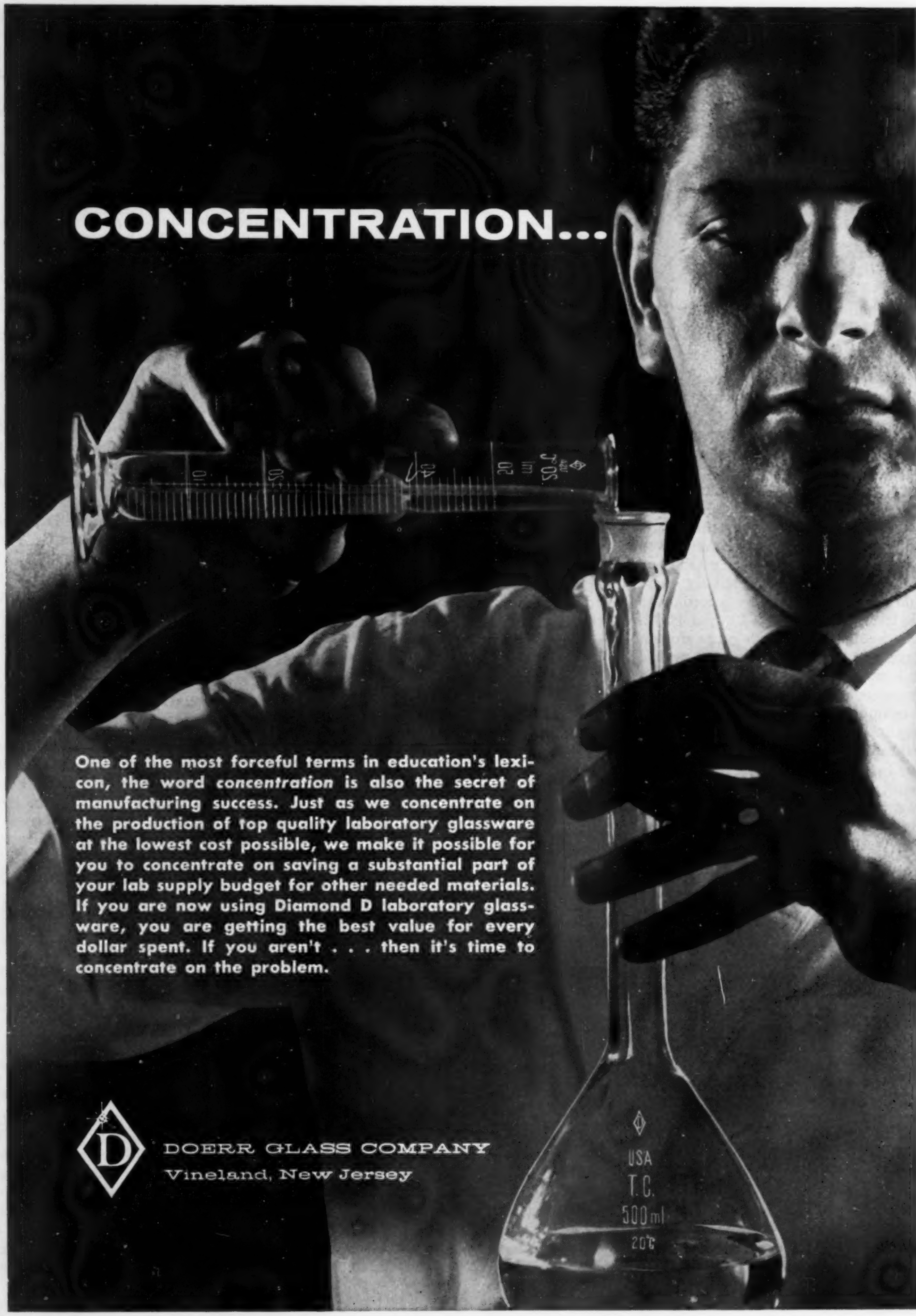
Themes for the three-day conference are: Today's World of Science; The Atom and Electricity, Biology, and Medicine; and Atomic Frontiers. Inspection tours of Argonne National Laboratory and the Dresden Nuclear Power Station will take place on the last day of the conference, and delegates will also have an opportunity to tour the famed Museum of Science and Industry. The U. S. Commissioner of Education, Dr. Lawrence G. Derthick, said recently, "I can think of no one thing which at this moment is more important than they [the students] be shown, by leaders in the field, what the meaning and implications of nuclear energy may hold for their future."

U. S. Registry

The U. S. Registry of Teachers of Science and Mathematics will be prepared for the 1960-61 school year under a grant from the National Science Foundation. This year's registry will be compiled anew from previous registries so that data may be used for special statistical studies to be made when the registry is completed. These studies will be done in conjunction with the NSF.

Suggestions Report

This column will report suggestions which are received from teachers, educators, NSTA staff, and other interested persons on the development and progress of the FSA program. As these suggestions and recommendations are received, they will be circulated and evaluated by the Field Advisory Board (FAB) of FSA. If the submitted material is selected by the FAB as an item or project to be incorporated in the FSA program, notification will be made under this subject head to keep you fully aware of developments. Full credit and acknowledgment will be made for each suggestion or recommendation upon advice and direction of the FAB group.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BOOK Reviews

This Is the American Earth. Ansel Adams and Nancy Newhall. 90p. $15. San Francisco Sierra Club, Mills Tower, San Francisco, Calif. 1960.

Publishers are notorious—or ought to be—for the exaggerated claims they make for the books which bear their imprint. But when the Sierra Club, in announcing *This Is the American Earth,* said, "There was never before a book like this," they were, I think, stating the truth.

Here we have first of all a beautiful physical production, a quarto handsomely designed, composed, and printed. I would say that no expense was spared in its production and the result is a vindication of the loving labors of Nancy Newhall and of David Brower, the indefatigable executive director of the Sierra Club of San Francisco, first and foremost of our many devoted conservation organizations.

When you examine *This Is the American Earth* you will be struck at first by the magnificent photographs which embellish it—the work of some twenty distinguished men and women, among them Margaret Bourke-White, Henri Cartier-Bresson, and it is not invidious to say, best of all, the incomparable Ansel Adams. They give you superb evocations of some of the most magnificent of our great national parks—Yosemite, Acadia (here, curiously enough, a misprint in a caption—Arcadia), Sequoia, Grand Teton, Yellowstone, Mount McKinley, Mount Rainier, and Glacier.

But there are wonderfully evocative pictures of logging and cattle driving, duck hunting, hydraulic mining, contour plowing, beautiful California pasture country **(see front cover),** animals, birds in flight, and even the metropolitan cities of Los Angeles and San Francisco—some eighty-five pictures in all.

As for Miss Newhall's text, one can only say that it does justice to the magnificent American heritage which inspired it—a long, eloquent prose poem which illuminates the beautiful photographs and is in turn illuminated by them. This American earth, she reminds us, we all inherit. "It is ours, to love and live upon, and use wisely down all the generations of the future." And never did we need so much to be reminded of this as in our present technological age when more of our people travel further and faster than ever before and see, as they travel, less than ever before. The national parks and forests and seashore resorts and wilderness areas—we have them in what to many seems an abundance. But we need more, and those we have, we keep only at the cost of continual struggle. In the world of conservation, battles are won—but the war, never.

This Is the American Earth owes its existence first of all to **Ansel Adams,** who suggested an exhibit of photographs and texts that would combine to explain what national parks are really all about. This exhibit, first shown in the Sierra Club's little building in Yosemite Valley, has enjoyed, through the good offices of the Smithsonian Institution and the United States Information Agency, a world-wide audience. But those of you who did not see the exhibition can enjoy the book. I have gone through it myself many times, and though ordinarily a reviewer may be expected somehow, somewhere to find something in the work he is reviewing which he would have otherwise, I can only say that the work of Mr. Adams and Miss Newhall has resulted in something beyond reproach.

One word more. The price, fifteen dollars, may seem high, but the mechanical beauty of the volume fully justifies it.

ALFRED A. KNOPF
New York City

The Search for Order. Cecil J. Schneer. Foreword by Henry Margenau. 398p. $6, Text Edition $4.50. Harper & Brothers, 49 East 33rd St., New York 16, N. Y. 1960.

All too rarely an exciting book on the history of science appears—this is one of them. The subtitle—Development of the Major Ideas in the Physical Sciences from the Earliest Times to the Present—more adequately describes the approach, which is comparative and developmental rather than strictly historical. In this sense, the book is reminiscent of the classic volumes by Loeb, *The Development of Physical Thought,* and by Richtmyer, *Introduction to Modern Physics.*

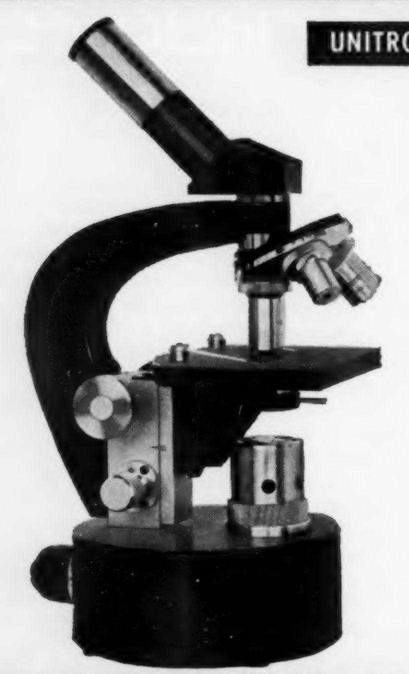
The author is to be congratulated for what must have been an exhaustive reading and selection task, and he has selected wisely. He has knit together the fabric of the several sciences into a cogent treatment of the evolving rationale of scientific investigation.

In the twenty chapters, titled Science, Magic, and Religion (Science as Control over Man's Environment); Order and Regularity in the Natural World; Greek Rationalism and Plato's Problem; Galilean Science; The End of Plato's Problem; The Idea of Mathematics; The Wonderful Machine; The Triumph of Mechanism; The Composition of Things; History in Science; Heat, Work and Energy; The Microscopic Model; Electricity and Magnetism; Ether and Light; Probability and Chance; The Fall of Matter; Classical and Nonclassical Science; The Theory of Relativity; The Fall of Causality; and Science in Mid-Twentieth Century; he has extracted the golden logic and even a bit of the philosophy which guided outstanding thinkers through creative activity. He has captured the flavor of controversy which makes the study of science progess so fascinating, e.g., the celebrated Newton-Hooke debates. Except for Chapter 6 on Mathematics, which seemed to this reviewer to be weak and unduly compressed, the treatment is well balanced. It is not an easy book to read because of the heavy concentration of material, but it is richly rewarding if one is willing to take time to read slowly and to reread passages. The author writes and organizes very well the great mass of subject matter he covers and has introduced leavening items of humor on occasion.

In the hands of a good teacher, this book could be an excellent text for a course in the physical sciences. It would probably yield richer permanent dividends to the student than most of the strictly informational or factual texts available.

The publishers have produced an attractive book and are to be congratulated for resisting the temptation to fill the volume with woodcuts of bewiskered scientists or

UNITRON student microscopes offer



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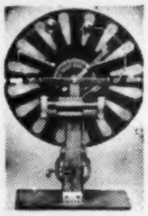

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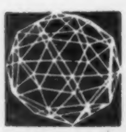

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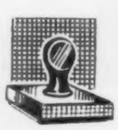

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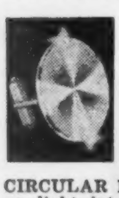

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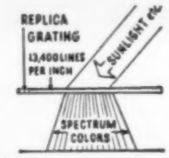

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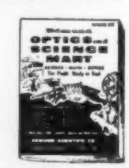

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ancient scenes. This book should be read and "browsed" by every high school teacher and by every college teacher as well. It should be in every science teacher's personal library and available in schools for reference by the superior student. The author's final statement on Science and Truth is worthy of framing, even though the reviewer does not agree that practical producers are second-rate scientists—indeed one cannot draw a line between pure and applied research. Perhaps, too, the author is "too hard" on the position of religion in an age when superstition, ignorance, and authoritarianism were rife. Yet this is a fine book and can be commended for study by every intelligent reader.

WILLIAM H. POWERS
The Pennsylvania State University
University Park, Pennsylvania

Atoms, Molecules, and Chemical Change. Ernest Grunwald and Russell H. Johnson. 252p. $6. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1960.

This book is intended to be used for an introduction to chemistry as part of a general education program in the physical sciences. The authors begin with a description of the nature of mixtures and pure substances, followed by the concept of chemical change. They discuss the laws of chemical change, the concepts of molecular formulas and weights, as well as the manner in which energy is associated with the kinetic molecular theory of matter.

The structure of the atom is developed from the failure of the Daltonian atom, the Bohr theory of the hydrogen atom, and the many electron systems through to the electron-orbital model of the atom. The periodic chart of the elements is developed from the historical approach. Ionic and covalent compounds are discussed with emphasis on the structure and reactions of covalent molecules. The last two chapters deal with the atomic nucleus and its reactions.

The book is well written and easy to read. Very little mathematical background is required. Each of the subjects is pursued to great depth, perhaps beyond the easy comprehension of the reader not previously exposed to chemistry, but a worthy challenge to the serious student.

Little attention is paid to other matters of importance in a general education, such as the role of chemistry in industry, and the economy of nations. Although some chemical reactions are described, no chemical processes are mentioned. It is a book of chemical and physical principles.

The science teacher will find the book useful as a clear, largely nonmathematical account of the structure of matter, using the historical approach to the development of our present-day understanding of the subject.

RALPH G. ASCAH
The Pennsylvania State University
University Park, Pennsylvania

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee

Chairman: Dr. H. Seymour Fowler

The Pennsylvania State University, University Park, Pennsylvania

NSTA Teaching Materials Review Committee

The Teaching Materials Review Center has been transferred from Northern Illinois University to the campus of Pennsylvania State University under the chairmanship of Dr. H. Seymour Fowler. The former chairman of the Teaching Materials Review Committee, Dr. Robert A. Bullington, has accepted an overseas assignment and will no longer be associated with the project.

The purpose of this joint project between NSTA and Pennsylvania State University is to continue reviews and reports on teaching materials used in elementary and secondary school science programs. The materials will include books, films and filmstrips, tape recordings, charts, laboratory apparatus and equipment, and related items. After review, the materials will be retained in appropriate depositories of the Pennsylvania State University for use by students, faculty, or visiting educational groups.

Readers are encouraged to send correspondence or materials directly to DR. H. SEYMOUR FOWLER, College of Education, Pennsylvania State University, University Park, Pennsylvania. Suppliers and publishers of science teaching materials are also requested to send items for review and examination to Dr. Fowler.

Chairman Fowler will be assisted by committee members, as follows: Dorothy Alfke, George Free, and Burton Voss of Pennsylvania State University, University Park, Pennsylvania; Wilbur Gilham, Philipsburg-Osceloa High School, Pennsylvania; Robert Isenberg, Altoona Senior High School, Pennsylvania; Herman Kranzer, Temple University, Philadelphia, Pennsylvania; and Robert Nelson, State College Junior High School, Pennsylvania.

BOOK BRIEFS

Careers in Physics. Revised Edition. Alpheus W. Smith and Winston L. Hole. 310p. $5.95. Long's College Book Company, 1836 North High St., Columbus 1, Ohio. 1960.

Presents physics as a way of thinking and as a profession, followed by short descriptions of the various fields of specialization, including interdisciplinary specializations. A major portion of the book discusses teaching and research, industry, and Federal service. Special attention is given to the nuclear sciences and to research institutes. Contains appendices of Nobel laureates, journals, research laboratories, and selected sources and references. For high school students and college undergraduates.

Biology. Elsbeth Kroeber, Walter H. Wolff and Richard L. Weaver. 646p. $3.99. Workbook and Laboratory Manual, 236p., $1.41. Teacher's Manual, 78p., 60¢. Comprehensive Tests, 76p., 54¢. Key to Comprehensive Tests, 10p., 28¢. D. C. Heath and Company, 285 Columbus Ave., Boston 16, Mass. 1960.

A new edition of an excellent biology text, outstanding in its clarity and simplicity of presentation. The authors have a style of presenting material that is meaningful to the high school biology student. Includes a new and well-presented unit on space and radiation biology. Relationships to biochemical concepts simply and clearly presented. Excellent illustrations, including Kodachromes. Summarizes important concepts at the end of chapters, stresses new terms, poses good problems, and lists pertinent supplementary readings.

Electricity. Arnold Mandelbaum. 158p. $2.95. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.

This informative book will prove a fine supplementary aid to units on the subject. It is well written, giving a broad and interpretive survey of the historical developments in electricity. Illustrated with drawings. Recommended for late elementary and junior high.

Find a Career in Medicine. Robert S. Starrett. 160p. $2.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.

Informative source for those contemplating careers in the medical fields. Discusses standards and training, aptitudes, and specific preparation required for admittance to medical schools. Focuses primarily upon the physician, but gives information regarding the many fields and vocations related to medicine. This is the kind of book needed for guidance information in the junior and senior high schools.

Choosing a Career in a Changing World. Virginia Veeder Westervelt. 160p. $2.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

A sensible guide which assists students in determining what they want in a job. Helps them to analyze themselves and to assess mental, social, physical, and moral traits. Students are guided into determining the kind of education they need and what it entails. Guidance is also given on how to get a job and how to make good on it. Especially strong in helping students in evaluating themselves and discovering their interests and aptitudes.

Adventures in Nature. Edwin Way Teale. 304p. $4. Dodd, Mead & Company, 432 Fourth Ave., New York 16, N. Y. 1959.

This might be termed "the best of Teale." The thirty-one selections have been taken from six of the author's earlier works. Anyone who enjoys the out-of-doors will share the thrill of Teale's intimate experiences with many facets of nature in widespread parts of the United States. The keen observations of this versatile naturalist are described with warmth and enthusiam that hold the interest of the reader. Of special interest to biology students.

The Voyage of the Beagle. Charles Darwin. Abridged and edited by Millicent E. Selsam. 328p. $3.95. Harper & Brothers, 49 East 33rd St., New York 16, N. Y. 1959.

The Voyage of the Beagle will delight the scientist and the adventurer, young or old. This five-year record allows us to travel with Darwin on his journey around the world. With him we discover the wonders of strange new lands. Descriptions of the inhabitants of these places, such as those of the gauchos of Argentina, are vivid and show us the warm, friendly, but curious attitude with which he met these people. The wonderful world of living things and the fossil records of ages past made Darwin wonder about the relationship between the two. Scattered through his notes we find his observations on the evidence showing the change that animals had undergone. This book also reveals the character and personality of Darwin. His sensitive nature, his zeal for discovering and collecting new things, his ability to make friends, and his love of all living things are shown in every chapter.

Modern Chemical Magic. John D. Lippy, Jr. and Edward L. Palder. 164p. $3.95. The Stackpole Company, Harrisburg, Pa. 1959.

Interesting demonstrations popularize various chemical reactions. Plenty of magic stunts included to give flavor by adding to the dramatic side of science. Deals with chemicals that are easily used and gives advice regarding properties and care in use.

Laboratory Exercises for Physics. Harvey E. White, with the assistance of Eugene F. Peckman. 184p. $2.96. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 1959.

The exercises in this paperback manual, designed to accompany the text by the same author, provide precise and definite verification of principles previously discussed in class and in the theory provided by the author for each exercise. Instructions in the minutest detail are provided. The student who follows the directions closely cannot go wrong. A set of data is even included for each exercise, in case the school does not provide the essential equipment for carrying out the exercise in the laboratory. Nothing is left to the student's imagination.

Physical Science for Progress. Milton O. Pella and Aubrey G. Wood. 516p. $3.60. Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. 1959.

This new text presents a variety of concepts in the physical sciences at a level within the capabilities of the average high school student who is not enrolled in physics or chemistry and has a limited background in mathematics. It includes both historically significant and modern topics in an interesting and effective manner. There are 16 units ranging from the nature of the universe through the solar system, structure of the earth, composition of matter, the atmosphere, water, harnessing of energy, machines, communication, light, weather, shelter, clothing, and health. A teacher's manual, a companion workbook, and a series of unit and quarterly tests complete this new and attractive contribution to the study of the physical sciences. Profusely illustrated.

An Annotated Guide to Free and Inexpensive Health Instruction Materials. John R. LeFevre and Donald N. Boydston. 72p. Cloth $5. Paper $2.50. Southern Illinois University Press, Carbondale, Ill. 1959.

This book should prove helpful to both the teacher and the student in the field of health. Materials are listed for grades 1-12 and also for the college level. For easy reference the section entitled "Materials Locator" arranges the material according to category, grade level, and topic. Main section of the book offers brief descriptions of the teaching materials, and instructions are given for ordering these materials singly or in large quantities. With this book, a teacher has at his finger tips sources of current, inexpensive health materials which can be used either as teaching aids or for class distribution.

Simple Machines and How They Work. Elizabeth N. Sharp. 84p. $1.95. Random House, Inc., 457 Madison Ave., New York 22, N. Y. 1959.

Filled with many practical suggestions, illustrations, and easy-to-do experiments with simple machines. Reading level is fourth and fifth grade, but the illustrations would prove very useful in presenting basic science principles at the sixth-grade level. The last chapter suggests additional places to look for machines. The book will increase the student's awareness of his surroundings.

Fundamentals of Guided Missiles. Air Training Command of the United States Air Force and the Technical Staff of Aero Publishers, Inc. 576p. $12.50. Aero Publishers, Inc., 2162 Sunset Blvd., Los Angeles 26, Calif. 1960.

A very important book covering the fundamentals of the entire field of guided missiles. Broad areas treated are aerodynamics, propulsion, instrumentation, electronic controls, and guidance systems. Illustrated with 576 photos and drawings. Includes comprehensive glossary of guided missile terms. An invaluable reference for any teacher or student interested in this rapidly expanding field.

Wildlife in Danger. Ivah Green. 128p. $3.50. Coward-McMann, Inc., 210 Madison Ave., New York 16, N. Y. 1960.

Thirty extinct or endangered birds and mam-

mals are briefly described and illustrated. Interesting, but general, remarks concerning habitat, life cycle (i.e. nests), feeding habits, and distribution are presented for each species. The author stresses, in a fashion understandable by upper elementary and junior high students, the causative effect of man upon animal extinction. Availability of this book to the present generation may aid in preventing the persecution of many species of wildlife.

A Book About Bees. Edwin Way Teale. 208p. $3. Dodd, Mead & Company, 432 Fourth Ave., New York 16, N. Y. 1959.

A new edition of the book originally published as *The Golden Throng*. The writing of naturalist Teale is factual, refreshing, and delightfully fascinating. Contains much material of a general entomological nature and is interspersed with many excellent photographs of his own taking. Highly recommended for the library of every biologist.

Wonders at Your Feet. Margaret Cosgrove. 64p. $2.95. Dodd, Mead & Company, 432 Fourth Ave., New York 16, N. Y. 1960.

Interesting seasonal treatment of the world of living things. Communities of plant and animal life introduced. Evolutionary development discussed in an informative style. Includes interesting descriptions of characteristics of many forms of plant and animal life. Well illustrated with both color and black and white drawings. Recommended for elementary and junior high.

PROFESSIONAL READING

"Science in Space." National Academy of Sciences-National Research Council, Washington 25, D. C. 1960. A series of reports are being published in nine parts. Those *currently* available are "The Nature of Gravitation," "The Earth," "The Planets," "Physics Fields and Energetic Particles in Space," "The Biological Sciences and Space Research," "The Moon," and "The Sun." Future publications include "Galactic and Extragalactic Astronomy" and "A General Review." These reports are written with a minimum of mathematical detail and in concise form. Sections on background and history are included when the authors felt this augmented the explanations. Each report published to date contains an adequate bibliography. The reports are available from the Printing and Publication Office of the National Academy of Sciences, 2101 Constitution Ave., N.W., Washington 25, D. C., for $1 each.

"Creative Thinking and Experimenting." By H. R. Crane. *American Journal of Physics,* 28:437. May 1960. Starting with the famous 1908 "Mathematical Invention" address of Henri Poincare, the author gives his interpretation of what creative thinking is and how it can be developed. He states ". . . this sounds like the sequence of steps in a detective story!" A distinction is made between how creative thinking is applied to science fair projects that are scientific investigations and those that are demonstrations. The author points out that projects that demonstrate do not provide for experience with the scientific process (method).

"New Trends in Science Education." By seven selected authors. *The High School Journal,* 43. March 1960. Excellent resume of new plans in science teaching. The authors seem to express one over-all philosophy—the "pursuit of excellence." In 40 pages, one receives what is probably the most complete and condensed version of new and radical experiments in science education.

"Energy Transformation in the Cell." By Albert L. Lehninger. *Scientific American,* 5:102. May 1960. Recently, energy transformation in living things has been an area of great research activity. This is an area which deserves rethinking by teachers. It is not a simple matter of food plus oxygen producing carbon dioxide, water, and energy. It is a series of enigmatic reactions, some of which take place in cell membranes.

"Understanding Testing." Guidance, Counseling, and Testing Section, U. S. Department of Health, Education, and Welfare, Washington, D. C. 1960. Provides basic facts about various tests, how they are constructed, and how they are to be used. Contains a glossary of commonly used measurement terms. Single copies are available for 25¢ through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

AUDIO-VISUAL AIDS

Airplanes, Jets and Rockets. Detailed diagrams and cutaway views effectively describe and explain the principles of powered flight and the impact of aviation upon today's world. The filmstrips are closely correlated with textbooks, supplementary reading material, and classroom activities. Filmstrips: *What Makes an Airplane Fly?* 42 frames; *How Is an Airplane Controlled?* 29 frames; *Safety in Flight,* 37 frames; *How Do Helicopters Fly?* 33 frames; *How Do Jets Fly?* 40 frames; and *Rocket Power for Space Travel,* 40 frames. Recommended for upper elementary and junior high grades. Color. Set $31.50; $5.75 each. 1960. The Jam Handy Organization, 2821 East Grand Blvd., Detroit 11, Mich.

Balance in Nature. A fascinating film showing in detail the life cycle of aphids and their enemies, the ladybird beetles. The details of aphid reproduction, metamorphosis, and feeding are clearly portrayed by excellent macroscopic photography. In similar fashion, the ladybird beetles are shown from egg through adult. The eating of the aphids by larvae and adults of the beetle is a most interesting feature. A useful film for any high school or college class in which these insects are studied. 17 min. Color $170. 1959. Filmscope, Inc., Box 397, Sierra Madre, Calif.

Space and Space Travel. Four filmstrips for intermediate and junior high grades that deal with space instruments and vehicles. Introduces the student to the meaning of new terms found in the study of space and space travel. Includes both drawings and photographs. Titles are: *Leaving the World,* 41 frames; *Current Events in Space,* 47 frames; *Man in Space,* 47 frames; and *Space Travel A.D. 2000,* 52 frames. Color. Set $21.60; $6 each. 1960. Society for Visual Education, Inc., 1345 West Diversey Parkway, Chicago 14, Ill.

Animals Protect Themselves. Shows how some common animals protect themselves from their enemies. Forms of protective behavior demonstrated are escape, body covering, camouflage, or fighting. A young boy, his father, and their dog take a walk and discover different types of protective behavior. Both field animals and zoo inhabitants are pictured. For grades 1-6. 11 min. Color $110, B&W $60. 1960. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

How We Know the Earth's Shape. A motion picture showing the globe as it is derived from the earth's shape. Various proofs are shown for its curved surface, including the ship phenomenon, moon eclipse, circumference sailing, and aerial view. Earth's variations from a true sphere are also discussed. The orbiting of satellites is shown. Useful aid in upper elementary and junior high school. 10 min. Color $110, B&W $60. 1959. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Microorganisms that Cause Disease. Five types of pathogens—the fungi, bacteria, viruses, rickettsiae, and protozoa—are shown by either the optical or electron microscope. Some excellent sequences show living microorganisms and their destructive effects upon cells or tissues. The importance of modern research techniques is made clear. A very good introduction to the study of pathogenic microorganisms in high school or college biology. 11 min. Color $110, B&W $60. 1960. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

APPARATUS & EQUIPMENT

Golden Capitol Weather Kit. Consists of "do-it-yourself" cardboard equipment for constructing a cloud identifier, humidity computer, wind direction and wind speed indicator, thermometer, simplified weather map, and includes the paper-bound Adventure Book of Weather. The equipment is easily put together but can be constructed only once. The equipment in the kit that was examined was not as accurate as it could be. The book is the best bargain in the kit. It is

colorful and interesting and the experiments described would be worthwhile for the intermediate grades. \$2.95. 1959. Capitol Publishing Company, Inc., 737 Broadway, New York 3, N. Y.

Athena I Rocket Kit and Propellant Set. Rocket developed specifically for study in high school science classes. Makes use of zinc dust and sulfur for propellant in capsules that can be preloaded and stored. Workmanship good, easily assembled, and the kit contains full instructions. Safety precautions properly emphasized. Good performance. \$8.20. 1959. Hi-Craft Company, 2345 Albatross Way, Sacramento, Calif.

Battery Chemistry Kit. Contains essential materials for generating electricity from different combinations of metals and solutions. Also parts for current detection equipment. Teacher's manual and student worksheets included with kit. Excellent for teaching basic electrochemical concepts such as battery assembly, electroplating, electrolysis, activity series, and classification of metals according to electrochemical properties. \$9.95. 1960. Product Design Company, 2796 Middlefield Rd., Redwood City, Calif.

Basic Electricity Kit. Includes bell, motor, lamp and socket, DC ammeter, battery, knife switch, connection board, spike, magnet, wires, fuse, resistance and hook-up wires. Helpful set of instructions included giving many suggestions for use. Should prove to be an excellent aid for general science teachers, and especially good for students in an activity-type program. \$17.50. 1960. Product Design Company, 2796 Middlefield Rd., Redwood City, Calif.

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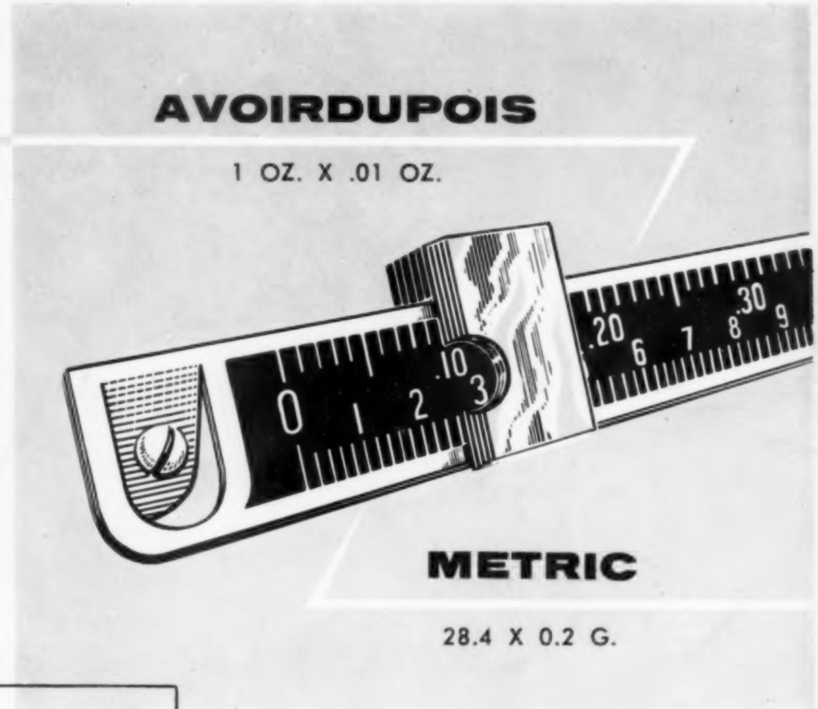

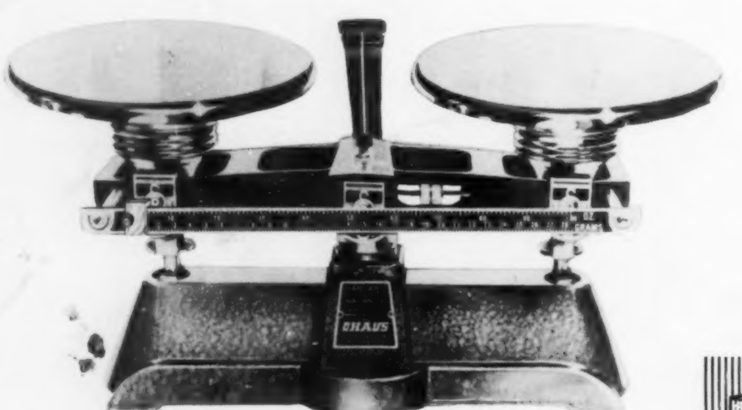

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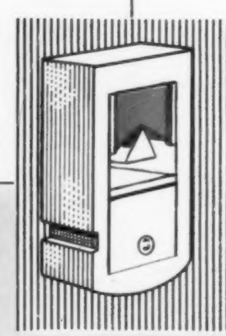

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